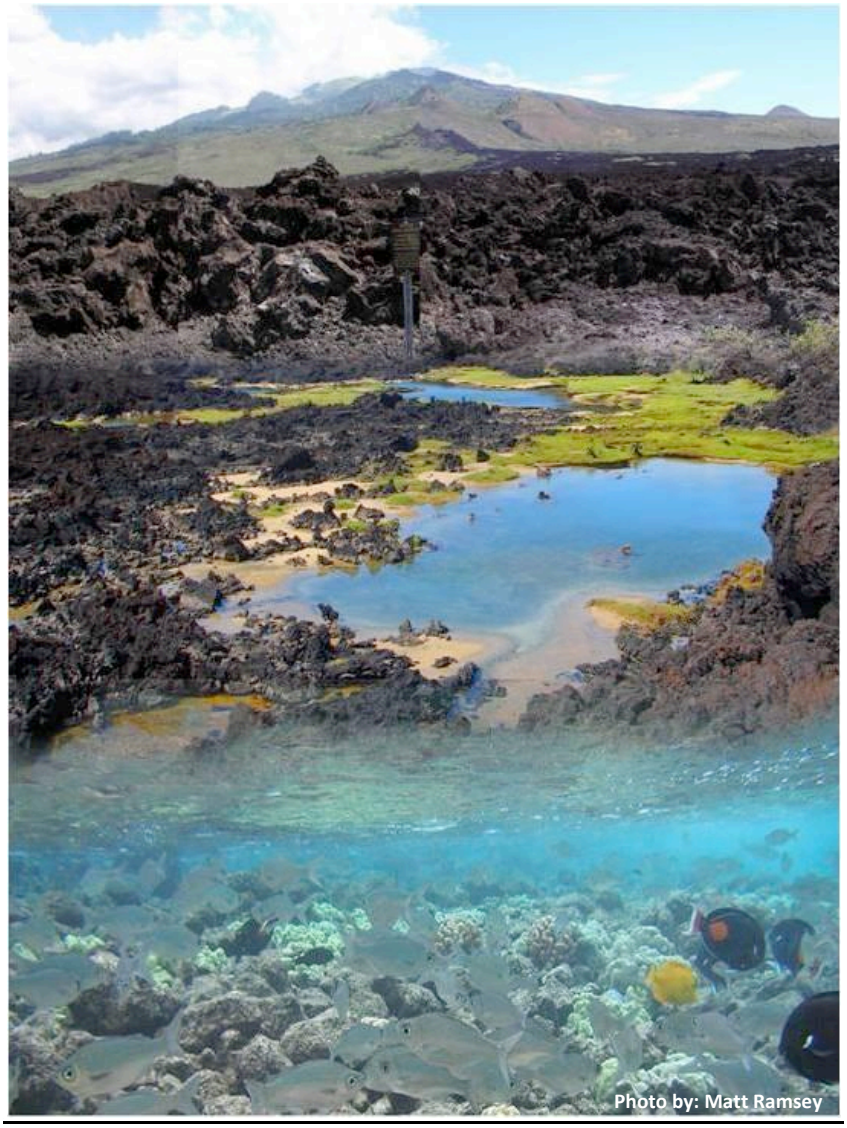
ʻĀhihi-Kīnaʻu Natural Area Reserve
Draft Management Plan



Department of Land and Natural Resources
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Acronyms

BLNR	Board of Land and Natural Resources
CRAMP	Coral Reef Assessment and Monitoring Program
CRMP	Cultural Resource Management Plan
CMP	Conservation Measures Partnership
DLNR	Department of Land and Natural Resources
DAR	Division of Aquatic Resources
DOCARE	Division of Conservation & Resources Enforcement
DOFAW	Division of Forestry and Wildlife
HAR.....	Hawaiʻi Administrative Rules
HIMB	Hawaiʻi Institute of Marine Biology
HTA	Hawaiʻi Tourism Authority
HWF	Hawaiʻi Wildlife Fund
HRS	Hawaiʻi Revised Statute
MLCD	Marine Life Conservation Districts
MPD	Maui Police Department
NOAA	National Oceanic Atmospheric Administration
NPS	National Park Service
NAR.....	Natural Area Reserve
NARS	Natural Area Reserves System
NARSC	Natural Area Reserves System Commission
RTCA	Rivers, Trails, and Conservation Assistance
SMA	Special Management Area
TMK	Tax map key
TNC	The Nature Conservancy
UNESCO	United Nations Educational, Scientific & Cultural Organization

Forward

We invite you to join us in learning about the ʻĀhihi-Kīnaʻu Natural Area Reserve (NAR), a rich and exceptional young volcanic landscape. Established in 1973 for the protection of Hawaii's biodiversity, ʻĀhihi-Kīnaʻu is the first Reserve of the Natural Area Reserves System (NARS), and the only NAR that includes the ocean. Inspired by the areas' stark beauty and natural and cultural resources, residents and visitors have invested countless hours of volunteer time and community action to ensure the ʻĀhihi-Kīnaʻu NAR is well cared for. This plan extends this legacy of public investment.

The planning process began with input from the Hawaiʻi Department of Land and Natural Resources (DLNR) Advisory Group in 2004 and was reinvigorated in 2008 through a partnership between the Natural Area Reserve System and The Nature Conservancy's Hawaiʻi Marine Program. These partners convened a diverse working group of 20 members who met together in more than 15 meetings between 2008-2010 to establish the vision, priority resources, threats, goals, objectives and strategic actions for preserving the ʻĀhihi-Kīnaʻu NAR. The working group finalized this draft plan in August 2010 and now invites input from the public, the NARS Commission and the Board of Land and Natural Resources (BLNR).

The purpose of this document is to describe the management actions needed to "preserve, protect, and enhance" the biological and cultural resources of the ʻĀhihi-Kīnaʻu Natural Area Reserve for current and future generations. It also acts as an institutional memory of past actions and a description of the status of resources and management today that can serve as a baseline of knowledge and comparison in the future.

This document has two sections: Section 1 provides context for the reader. It includes the setting, history, and description of the threats and resources. Section 2 describes a comprehensive set of prioritized actions, a budget, sustainable finance plan, and measures which together form a framework for effective management. We have written this document primarily for agency managers, engaged partners, stakeholders, and decision makers. We also hope that it will be useful to the public and anyone wanting to learn more about the history, status and aims of the Reserve.

Thank you for your involvement and interest in the ʻĀhihi-Kīnaʻu Natural Area Reserve and this management plan. Learn more about the Reserve and how you can invest in the future of this unique Hawaiian place at http://Hawaiʻi.gov/dlnr/dofaw/nars/Reserves/maui/ahihikinau.

This plan is a draft which will be improved by input from our community. Public review and comment is open from October 20 to November 20, 2010. Please submit your comments on this plan at a public meeting on November 3, 2010, or via the web, fax or mail:

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Executive Summary

This plan is a call to action to protect and preserve the ʻĀhihi-Kīnaʻu Natural Area Reserve. The plan contains historical, management, and biological information, describes the current status and condition of the Reserve, identifies threats to the natural and cultural resources found there, and suggests actions that both welcome people and protect what is fragile and rare.

Though unintentional, people's love for and appreciation for this beautiful resource has had some devastating impacts. To keep ʻĀhihi-Kīnaʻu in good health for today and for future generations, management is essential to reduce the impacts people and non-native plants and animals have on the area.

Under the Department of Land and Natural Resources, the State's Natural Area Reserves System (NARS) was established in 1972 to protect the best examples of Hawaii's remaining ecosystems and geological features (HRS §195-1). Each Reserve protects unique examples of community types found on different islands; therefore each Reserve is significant in its own right. The ʻĀhihi-Kīnaʻu Natural Area Reserve is the most heavily used of the 19 Natural Area Reserves. It is aesthetically beautiful, and biologically, culturally and geologically unique. The area offers some of the finest coral reefs in the main Hawaiian Islands below sweeping views of the Southwest Rift Zone, Kahoʻolawe, Molokini, Lānaʻi, Mauna Kahalawai (West Maui Mountains), and the ocean. Visitors can consider the continuation of geologic history from one of the youngest flows on Maui, to the older Maui Nui complex islands, and the regenerative and erosional forces of nature on the landscape. Native Hawaiian mythology describes many events through the features of this landscape. Some of the most well-preserved examples of Hawaiian endemic ecosystems associated with recent lava flows occur in the Reserve, both in the water (aquatic) and on land (terrestrial).

This management plan builds upon a process started in 2005 with a draft plan, written by the NARS Maui staff and submitted to the ʻĀhihi-Kīnaʻu NAR/Keoneʻōʻio Advisory Group. From 2008-2010, the management plan working group met in over 15 publically noticed meetings to build on that draft. This final draft also includes recommendations from other plans over the last 25 years and attempts to recognize and incorporate the substantial effort that has gone into caring for the Reserve since its inception (plans from 1992 and 1998 are discussed in Section 1.2.2).

The Reserve's resources are categorized into seven groups:

1. Anchialine pools
2. Coastal marine
3. Coral reefs
4. Cultural landscape
5. Lava flow
6. Native shrubland
7. Wilderness qualities

Actions are proposed under four goals: 1) Manage Human Use, 2) Control Alien Species and Other Biological Threats, 3) Prevent land-based Impacts, and 4) Build and Maintain the Reserve's

Management Capacity. Objectives and strategic actions lay out a course of action for the Reserve for the next five years under each of these four goals, as summarized below.

1. Manage Human Use

To manage human use for increased safety and decreased resource degradation, the Reserve is divided into two zones: 1) open-access area, and 2) restricted-access area. All visitor parking is directed to the Reserve's Kanahena Parking Area as a focal point for education, outreach, safety, and a volunteer program. The Reserve ranger program is continued and strengthened. From this base of operations, Reserve rangers lead guided hikes into the access-by-permit area. The open trail leading to ʻĀhihi Bay is open for self guided walks, and popular snorkeling areas at Kanahena Cove and ʻĀhihi Bay are open as well. Immediate protection of the most threatened cultural sites within and adjacent to the Reserve is prioritized. To preserve knowledge and awareness of the Reserve, a professional interpretation and information program is instituted to promote an ethic of caring for natural and cultural resources. Marine boundaries are marked, and a process to consider boundary changes to increase voluntary compliance with NARS rules is initiated.

2. Control Alien Species and Other Biological Threats

To manage alien species, goat and deer populations are assessed and controlled, and a *mauka* boundary exclusion fence built. Around anchialine pools and other sensitive native and seabird habitats, predators are removed. Non-native plants are controlled around anchialine pools and other rare plant areas. For non-native species in the marine environment, the threats are assessed and removed as necessary. Small scale native plant restoration will be tested and assessed, and a native plan restoration plan developed.

3. Prevent land-based Impacts

To prevent land-based pollution from impacting coral reefs, a buffer zone will be established within a one mile radius surrounding the Reserve to minimize encroachment and associated impacts utilizing a variety of collaborative tools. Sources of run-off within and adjacent to the Reserve will be assessed and best management practices developed. Actions are taken to reduce the impacts of light pollution on wildlife.

4. Build and Maintain the Reserve's Management Capacity

To build and maintain the Reserve's management capacity, a sustainable finance plan would establish a fee for each car entry at the Reserve's Kanahena Parking Area (Hawaiʻi residents exempted), a fee for guided hikes via an online system, and an increase in staff capacity for grant writing and grant management. The Reserve will hire a full-time Reserve manager, continue to support and seek guidance from the Advisory Group, and develop a short- and long-term facility plan that maintains the wilderness qualities of the Reserve and prioritizes resource preservation.

1.0 The History and Status of the Reserve

The natural and cultural resources of ʻĀhihi-Kīnaʻu are unique in Hawaiʻi and the world, and thus were protected from development and extractive uses more than 30 years ago. Today, threats to these sensitive resources have grown and changed to include visitors by the thousands, introduced species and other biological threats, more nearby development, and impacts of climate change. The type and intensity of change in today's world require that protected areas not just be set aside but also that they be managed. Effective management requires reliable human and financial resources and a landscape scale view of threats and opportunities to ensure that the biological and cultural landscape itself is cared for, and not hemmed in by human structures and activities and thus lose the inherent integrity that defines it as a unique Hawaiian place.

This section lays out the basic understanding of the setting of the Reserve and what makes it unique. Here we describe the geographical, geological, biological, social, economic, cultural, and physical infrastructure setting of the Reserve. This is followed by a description of the management framework under the State of Hawaiʻi, Department of Land and Natural Resources, and an accounting of the rich and varied management history of the Reserve from its inception in 1973 to the present day. A categorization and description of how Reserve resources are being impacts by four types of threats, is followed by a discussion of the natural and cultural resources targeted for protection under this plan

1.1 Reserve Description and Setting

The State's Natural Area Reserve System was established in 1972 to protect the best examples of Hawaii's remaining ecology and geology. Each Reserve protects unique examples of community types found on different islands; therefore each Reserve is significant in its own right. The ʻĀhihi-Kīnaʻu Natural Area Reserve is the most heavily used of the 19 Natural Area Reserves. It is aesthetically beautiful, biologically and geologically unique, and culturally important. The area offers some of the finest coral reefs in the main Hawaiian Islands below sweeping views of the Southwest Rift Zone, Kahoʻolawe, Molokini, Lānaʻi, Mauna Kahalawai (West Maui Mountains), and the ocean. Visitors can consider the continuation of geologic history from one of the youngest flows on Maui, to the older Maui Nui complex islands (Lānaʻi, Kahoʻolawe and Molokaʻi), and the regenerative and erosional forces of nature on the landscape. Native Hawaiian mythology describes many events through the features of this landscape. Some of the most well-preserved examples of Hawaiian endemic ecosystems associated with recent lava flows occur in the Reserve, both in the water and on land.

1.1.1 Geographic setting

The ʻĀhihi-Kīnaʻu Natural Area Reserve (Reserve) is situated on the southern shoreline of the Hawaiian Island of Maui, in the *moku* (traditional land district) of Honuaʻula[1], on the southwest flank of the 3,055 m (10,023 ft) volcano of Haleakalā (Figure 1). It is within the County of Maui administrative district of Makawao near the town of Kīhei and resort areas of Wailea and Mākena. From north to south, the Reserve spans four *ahupuaʻa* (land division extending from the uplands into the sea). These are Onau, Kanahena, Kualapa, and Kalihi. The Reserve was named so because it includes both the land and sea around the lava flow named Cape Kinau[2]

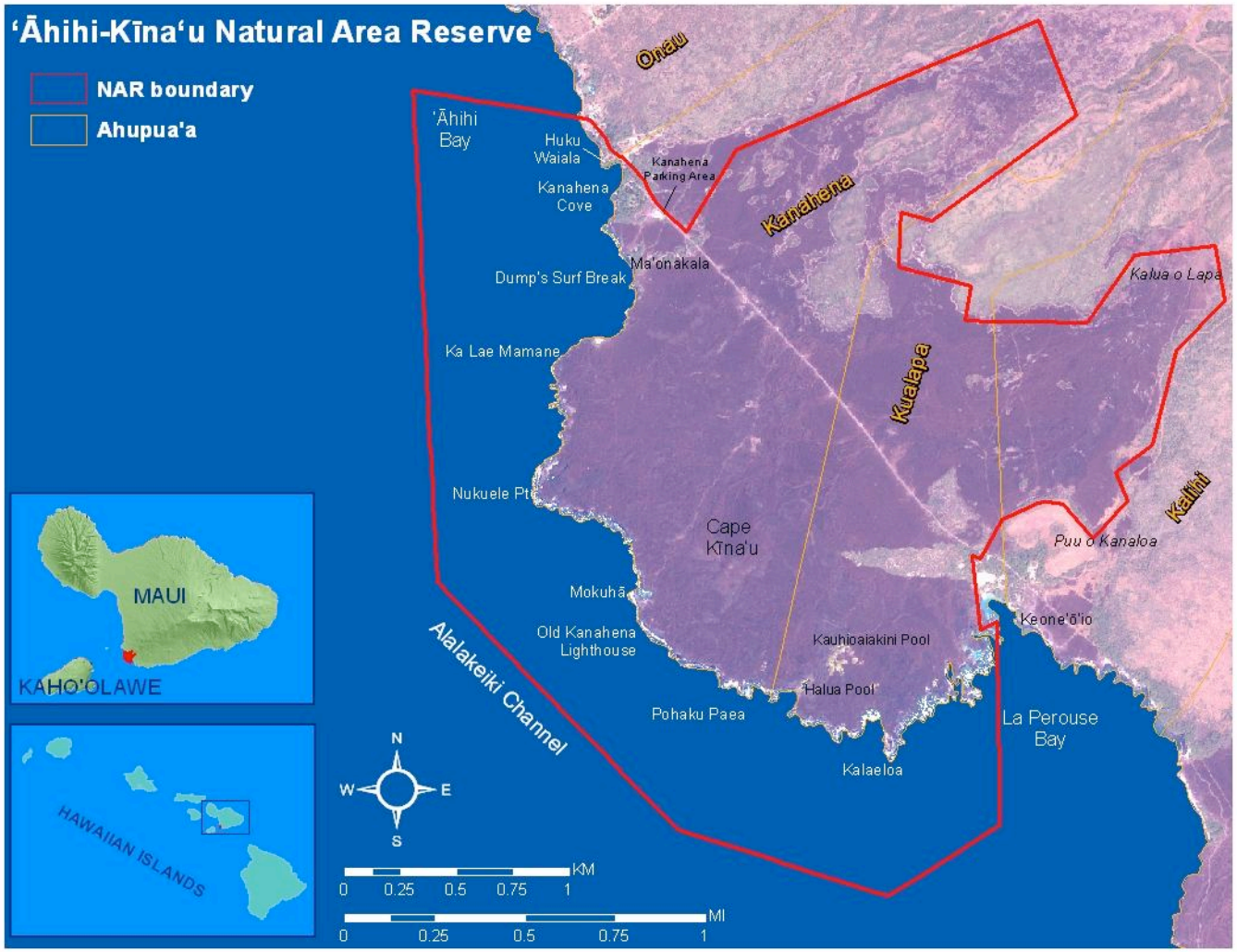

Figure 1. ʻĀhihi-Kīnaʻu Natural Area Reserve boundary and ahupuaʻa (map by Stephanie Tom).

situated at the southern end of ʻĀhihi Bay. The Reserve's geographic boundaries were drawn to encompass the entirety of the lava flow at Cape Kīnaʻu including its source vent at Kalua O Lapa and out onto the sea in portions of both ʻĀhihi and La Perouse Bays. The purpose and intent of the Reserve is to preserve and protect three unique components: 1) the geologic setting of the most recent lava flow on Maui; 2) unique assemblages of nearshore coral reef ecosystems; and 3) the anchialine ponds found there.

The 828 ha (2,045 acre or 8.3 km^2) Reserve consists of 327 ha (807 acres / 6.3 km^2) of submerged lands and 501 ha (1,238 acres or 5 km^2) of terrestrial area along 4.8 km (3 miles) of the southern coastline of Maui. The Reserve was created in 1973 and has the unique distinction of being the first in the statewide Natural Area Reserves System (NARS), the only Reserve to encompass marine ecosystems, and the only area on state lands where an entire lava flow is protected from its source to the sea. The size of ʻĀhihi-Kīnaʻu is average when compared to other Reserves in the NARS which vary greatly in size from the smallest at Kaena Point; Oahu (12 acres) to the largest at Manuka on the Big island of Hawaiʻi (25,550 acres) . Compared to the eleven State Marine Life Conservation Districts (MLCDs) which offer similar protections, the Reserve marine portion is nearly three times as large as the largest MLCD at Kealakekua Bay, Hawaiʻi.

Rainfall in the Reserve ranges from 400 mm (15 inches) along the coastline, to 600 mm (24 inches) per year along the *mauka* (upland) boundary. There is distinct seasonal variability in rainfall, with much of the precipitation from winter storms. The highest point in the Reserve is Kalua O Lapa at 158 m (520 feet) elevation. Below sea level the lowest point is -35 m (-115 feet). Solar radiation here is among the highest in the State. The dark color of the lava absorbs solar radiation creating warmer conditions within the Reserve than in surrounding areas (500 calories/m^2/day) (Rodgers et al. 2008).

1.1.2 Geologic setting

The geology of the Reserve is among the youngest on the island and is home to a wide variety of unique ecosystems and creatures. Much like its neighbor, Haleakalā National Park, the Reserve landscape allows for a glimpse into the geologic history of Maui and the processes of volcanic islands.

The Reserve encompasses young rugged lava flows on Haleakalā volcano's southwest rift zone (Figure 2). The Reserve includes the Kalua O Lapa cinder cone and *ʻaʻā* (stony rough) lava fed by it. These lava flows reach seaward, forming Cape Kīnaʻu and coating the adjacent offshore sea floor. Also within the Reserve is the coastal part of an older, similar sequence of lava flows that lies to the northwest of the Kalua O Lapa lava. This older sequence, the Kanahena flows, was erupted from an unnamed fissure at about the 430 m altitude (1,400 ft) on the southwest rift zone. Since the Reserve boundary on land was specifically designed to encompass the entirety of the lava flows, X% amount of the Reserve is barren lava, primarily very rough and jagged *a`a* lava with some smooth *pahoehoe* lava. Because of the extent of barren, unvegetated flow and the extreme roughness and fractured nature of the lava itself, the area is extremely difficult to traverse on foot. Thus, the Reserve functions as an outdoor natural history classroom that provides many opportunities to educate, and create awareness that the landscape found here is a representative example of the geologic forces that created the Hawaiian archipelago.

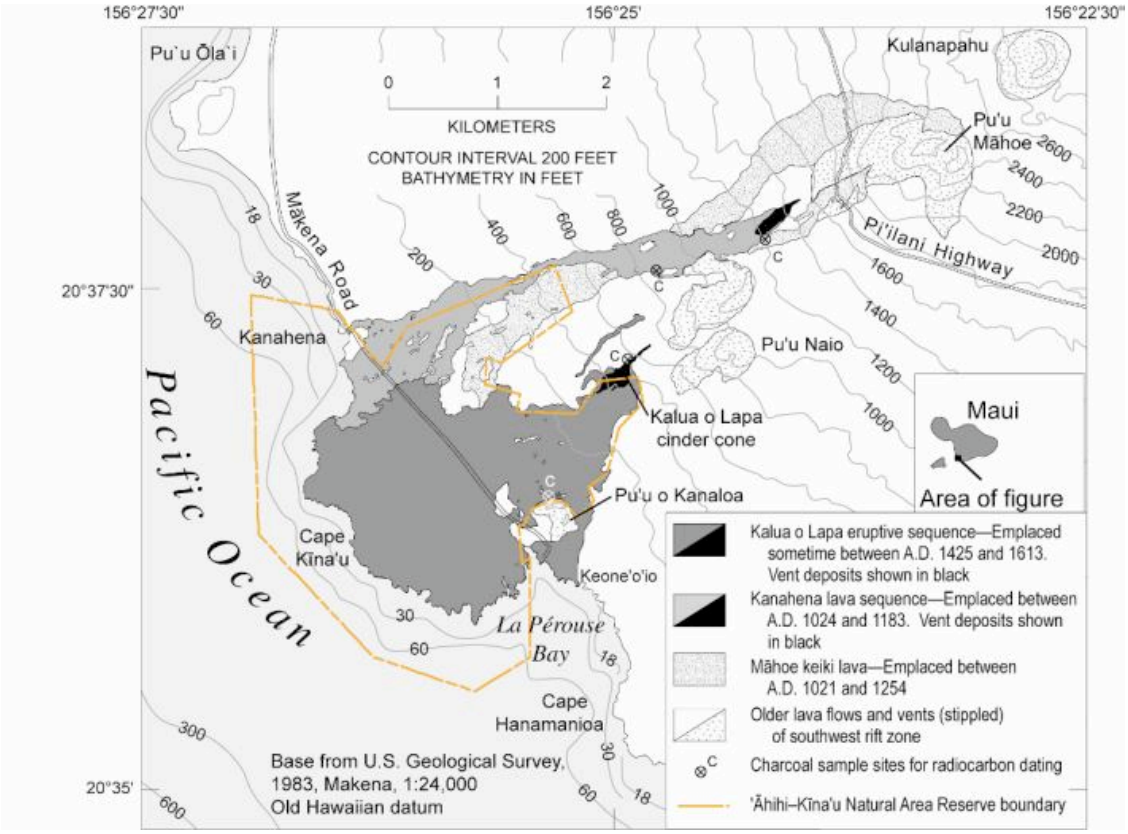

Figure 2. Generalized geologic map showing young lava flows on lower southwest rift zone of Haleakalā volcano (map by Dave Sherrod).

Two radiocarbon ages have been determined from charcoal collected from beneath Kalua O Lapa lava flows and spatter deposits (Sherrod et al. 2006). The ages, when averaged together, indicate the lava flows were emplaced sometime between A.D. 1419 and 1621. This range of calendar ages is a calibrated age, adjusted to account for the varying abundance of the carbon-14 isotope over time.[3]

Five other eruptive sequences younger than about 500 years in age are known from East Maui (Sherrod et al. 2006). The Kalua O Lapa sequence may not be the youngest of Maui's volcanic events, but it certainly is among them. Two radiocarbon ages from charcoal beneath the Kanahena lava flows leave its age unresolved. Of these, the older age is more likely correct, corresponding to an eruption between A.D. 1024 and 1183, or about 800–900 years ago (Sherrod et al. 2006). In instances like this, the younger age commonly is too young, a result of younger roots penetrating through or along the margins of a lava flow and then being burned by range fires that are unrelated to the volcanic event in question. (Note: More on the geologic history of the Reserve can be found in section *2.1.5 Lava flow formations and habitats.)*

1.1.3 Biological Setting

On a worldwide scale, the oceanic islands of Hawaiʻi are biologically significant because of extremely high levels of endemism. More than 90% of Hawaii's native plants and animals, an estimated 15,000 species, are found only in Hawaiʻi. Today, more than twenty five percent of Hawaii's plants, animals, forest birds, and land snails are now rare and Hawaiʻi is home to more endangered species than any other state in the U.S. (TNC 1998). Hawaii's coral reefs and nearshore waters are home to more than 7,000 species, a quarter of them found nowhere else in the world.

Some of the most pristine examples of Hawaiian endemic (species found only in Hawaiʻi) ecosystems associated with recent lava flows occur in the Reserve. Biological resources include anchialine (shallow brackish-water) pools, coastal marine habitats, coral reef ecosystems, lava flow formations and habitats, remnant native leeward shrublands and forests, and connections between these used by native wildlife. (Note: Each of these resources is described further in Section *2.1. Priority Natural and Cultural Resources Targeted for Protection.*

Anchialine pools are surface brackish-water pools, fed underground from both marine and fresh water sources, and lack a surface connection to the sea. The word anchialine is derived from the Greek word "anchialos" meaning close to the sea. **Anchialine pools are globally rare and Hawaiʻi is home to the only natural representatives in the U.S. as well as the largest concentration of them on the planet (Santos 2010).** There are 12 groupings of the unique pools at Cape Kīnaʻu, including the largest in the State. **The diversity of shrimp in the pools is the greatest known in the Indo-Pacific,** and five of the ten species are listed as candidate species under the Endangered Species Act (ESA). The pools provide habitat for waterbirds, shorebirds, and migratory birds, native herblands and algae. The endangered *ae`o* or Hawaiian stilt (*Himantopus mexicanus knudseni*) forage and nest in at least one of the anchialine pool complexes.

The complexity and low relief of the young lava shoreline provides distinctive coastal habitat types - sheltered bays, tide pools*, loko iʻa* (fishponds), and basaltic intertidal, each hosting unique assemblages of species. Deep inlets on the shore and anchialine pools were modified into distinctive *loko iʻa* by Native Hawaiians in ancient and modern times. The intertidal areas of the Reserve are notable for a diversity of native algae, and healthy populations of intertidal invertebrates such as urchins, limpets, and snails.

The coral reefs of the Reserve are among the finest in the main Hawaiian Islands. A long-term study of nine Maui reefs by the Hawaiʻi Institute of Marine Biology's Coral Reef Assessment and Monitoring Program (CRAMP) indicate that the reefs off of Kanahena were the only Maui reefs to increase coral cover in recent years (17-30% 1999-2006). At least 33 species of coral, 53 species of subtidal invertebrate, and 75 species of fish (17 endemic) were found . Five marine species with protected status frequent the Reserve: 1) Hawaiian Monk seal or *ʻIlio-holo-i-ka-uaua* (*Monachus schauinslandi*), 2) Hawksbill turtle or *ʻea* (*Eretmochelys imbricata*), 3) Green turtle or *honu* (*Chelonia mydas*), 4) Spinner dolphin or *naiʻa* (*Stenella longirostris longirostri*s), and 5) Humpback whale or *kohalā* (*Megaptera novaeangliae*). The entire marine portion of the Reserve is encompassed by the Hawaiian Islands Humpback Whale National Marine Sanctuary. The Hawaiian Monk seal, Hawksbill turtle, and Humpback whale are all listed as endangered under the ESA.

The particular nature of the Kalua O Lapa flow created lava tubes and depressions near the shoreline. Some of these depressions along the coastal stretch have floors that lie below sea level, allowing ocean water to infiltrate and form shallow ponds (such as the anchialine pools). In addition to aquatic habitats, these geologic characteristics created at least four unique native terrestrial habitats: 1) Aeolian (wind-supported) ecosystems on unvegetated lava; 2) Lava tube cave and associated subterranean voids; 3) Littoral (associated with the marine coast) habitats; and 4) Seabird nesting habitats.

Botanically, the Reserve is part of the lowland dry ecotype, although the Reserve is not best known for its botanical resources, being comprised almost entirely of un-vegetated barren lava. There are *kipuka* (vegetated oasis within lava bed) where remnant native plants are found among the dominant non-native trees. Compared to the historical extent of this ecotype for the island of Maui, **less than 2% of this native lowland vegetation is left today.** The life cycles of plants here are keyed to a very severe and prolonged dry season and variable wet season. The endemic *wiliwili* (*Erythrina sandwicensis)* is the dominant tree of the remnant native dry forest zone. The Reserve contains 21 native plant species, several of which are now rare (Hawaiʻi Heritage 1989). Native insects include the Blackburn's Sphinx Moth (*Manduca blackburni),* the first Hawaiian insect to be listed as endangered under the ESA. Critical habitat for the moth, designated in 2003, includes the Reserve.

Aesthetically, the views of the Southwest Rift Zone, Kahoʻolawe, Molokini, Lānaʻi, Mauna Kahalawai (West Maui Mountains), and the ocean are amongst the most spectacular found anywhere in Hawai`i and are magnificent to behold. It is also a view from which one can consider the continuation of geologic history from one of the youngest flows on Maui, to the older Maui Nui complex islands, and the regenerative and erosional forces of nature on the landscape. Native Hawaiian mythology describes many events through the features of this landscape. **Biologically, this connectivity is essential for wildlife that travels up and down the slopes of Haleakalā and along the shoreline.** Some species like the Hawaiian Petrel or *ʻuaʻu* (*Pterodroma sandwichensis*), fly from the upper elevations out onto the open sea. This land and seascape, relatively free of structures and lights, along with low noise levels, and clear air and sea space, all contribute to providing the high quality wildlife habitat found in the Reserve.

Table 1. The significance of the natural and cultural resources of the Reserve.

Natural and Cultural Resources of the Reserve[4]	State Significance	National Significance	Global Significance
Anchialine pools	●	●	●
Coral reefs	●	●	
Coastal marine habitats	●		
Cultural Landscape	●		
Lava flow formations and habitats	●	●	
Native leeward shrublands and forests	●	●	
Wilderness qualities	●	●	●

1.1.4 Social, Economic and Cultural Setting

The ʻĀhihi-Kīnaʻu NAR is one of the richest sites for archeological features and cultural landscapes in all of Maui. The rich cultural landscape of the Reserve includes both pre-European contact and post-contact Native Hawaiian village sites, *heiau* (religious sites), burials, trails, shelters, caves, *loko iʻa* (fish pond) complexes, ranching walls, a lighthouse site, as well as traditional place names, genealogies, records of travel, oral histories, ecological knowledge and mythology of Hawaiian deities. The cultural landscape includes the entirety of the landscape itself, the physical history, and living connections to the place and past. Cultural and historic sites are protected within the boundaries of the Reserve by Hawaiʻi Revised Statutes 13-209-4. Nine site complexes in the Reserve are on the Hawaiʻi Register of Historic Places, including the Maʻonakala Village Complex, Kualapa Cluster and Kauhuoaiakini and Halua Pool Complex (Desilets et al. 2007).

Early Polynesian settlement is thought to have begun via voyaging canoes from the Marquesas and Society Islands ca 400 A.D., with long distance voyages occurring regularly through at least the thirteenth century (Maly and Maly 2005). Permanent settlements of the dry coastal areas of Keoneʻōʻio and ʻĀhihi are thought to have occurred between 1000 and 1400 A.D (Deslits 2007; Maly and Maly 2005:22). Permanent Hawaiian occupation was based on use of marine resources and dry-land crops, dominated by *ʻuala* (sweet potato) cultivation in *mauka* (mountain) areas. Fish and other marine resources were important staples. The name Keoneʻōʻio refers to the *ʻōʻio* or bonefish (*Albula glossondonta*) which was once abundant. In 1786, La Pérouse noted as many as five villages within what is now in the area. These include Maʻonakala village at the far northern end of the Reserve in ʻĀhihi Bay, as well as four small villages in Keoneʻōʻio, each with 10 to 12 thatched houses. Those living at the shore focused primarily on fishing and had comparatively easy access to potable water at shoreline springs (Maly and Maly 2005). The residents traveled between the uplands and coast to trade products.[5]

As European and American merchants, whalers, and missionaries found more influence in the Hawaiian Islands in the 1800s, traditional society was drawn into the global market economy. Migration and disease contributed to rapid population decline in rural areas. In Honuaʻula, census data showed a decline between 1831-1836 from 3,340 to 1,911 (Schmitt 1973). By the mid-1840s land use in Honuaʻula transitioned from primarily traditional subsistence to agricultural business activities (Maly and Maly 2005:13). An estimated 150 people were living in or very near to the ʻĀhihi-Kīnaʻu NAR and Keoneʻōʻio in 1853 Coulter (1931). These changes in use were also associated with changes in land tenure, which eventually allowed government lands to become the Reserve.[6]

Of the Hawaiian government's improvements in this region in the 1800s, the most prominent and lasting was the government road built under the direction of Hoapili, governor of Maui from 1823-1840. While he held this position, he had a road constructed from Honuaʻula to Kaupō, running along the shore (Maly and Maly 2005:204). The Hoapili Road traversed the Reserve, and it is assumed that the current government road was built upon the Hoapili Road, obscuring its original construction. Today the historic road can be seen beginning in Keoneʻōʻio through Kahikinui. The Kanahena Lighthouse was installed on Kanahena Point in 1884 and tended by light keepers until a new light was built at nearby Cape Hanamanioa in 1918. Stone

fencelines and cattle trails from the years that the Reserve was leased by Rose and ʻUlupalakua Ranches are still visible in the *mauka* portion of the Reserve.

With the onset of World War II, the U.S. Military began conducting maneuvers in south Maui. Coastal areas were fortified with bunkers and amphibious landings were made at Mākena (Desilets et al. 2007). Some of the structures can still be seen at Oneloa Beach in Mākena State Park, and a concrete ramp from the era at Keoneʻōʻio. Following World War II, Cape Kīnaʻu was used for bombing target practice by the Navy from 1945-1946 (Parsons 2008) and unexploded ordinance is still present on Cape Kīnaʻu. The Reserve's Kanahena Parking Area (also known as "Dumps") was used as a dump site for metal debris, such as barbed wire, from around the coastline during and after the war (Robert Luʻuwai pers. comm. 2009). The popular surfing spot in the area "Dumps" is also named for the former dump site.

Beginning in the 1970s, Maui, more than any other Hawaiian Island, experienced dramatic population growth, doubling between 1980 (63,000) and 2000 (128,000) (Maui County 2006). The defacto island population (residents plus visitors) can be 30-50,000 more, depending on the time of year. Nowhere else is this growth more apparent than the area from Kīhei to Mākena where in 1980, a population of 7,263, lived in a quiet rural area with miles of uncrowded beaches and a few small hotels. Today, Kīhei-Mākena is the second largest tourism area on Maui with a population of more than 22,400, in a ten-mile stretch of urban development. With more residents and visitors in southwest Maui, and the paving of the government road to La Pérouse Bay/ Keoneʻōʻio in the 1990s, the Reserve and adjacent areas became an increasingly popular destination. As early as 2001, visitor counts by Friends of Keoneʻōʻio recorded 805 people per day and as many as 339 vehicles (CSV Consultants and Hawaiʻi Wildlife Fund 2007). Today the ʻĀhihi-Kīnaʻu Natural Area Reserve receives an average of 700 visitors per day or 250,000 visitors per year (Vann et al. 2006; CSV Consultants and Hawaiʻi Wildlife Fund 2007; Hawaiʻi Wildlife Fund 2008).

1.1.5 Physical Infrastructure Setting

There are few infrastructural improvements in the Reserve. A large sign is placed at the coastal entry on the Mākena-Keoneʻōʻio government road. Near the entrance there is a small (four to six vehicle) unpaved/dirt parking area over-looking the rocky coast. About 100 m further down the coast is an unpaved parking area adjacent to a privately-owned home. Within the parking area is a temporary building for ranger offices. Signs stating Reserve restrictions and the 2008-2010 access restrictions are located along the road, at the Maʻonakala parking area, at restricted access trail heads, and at La Pérouse Bay/Keoneʻōʻio, which is outside the Reserve. Portable toilets are provided at both Maʻonakala and La Pérouse Bay/Keoneʻōʻio parking areas. Overhead power lines and a water pipeline line the road that traverses the Reserve, serving the lone household at the end of the government road in La Pérouse Bay / Keoneʻōʻio.

1.2 Legacy of Protection

1.2.1 Management Context

a) Conserving biodiversity through protected areas

The loss of biodiversity is of great concern worldwide. Numerous international, national and local programs have been adopted to slow the loss of life forms on earth (Convention on Biological Diversity)**. Prime among them is the designation of place-based** conservation or protected area management. To sustain their biodiversity, most countries have developed a system of protected areas, which in 2008 covered about 12 percent of the Earth's land surface (Chape et al. 2008). Less than 1% of this is marine (World Database on Marine Protected Areas 2009). Protected areas are of crucial and growing importance because they:

1. Safeguard many of the world's outstanding areas of living richness, natural beauty and cultural significance, and are a source of inspiration and an irreplaceable asset of the country to which they belong;
2. Help to maintain the diversity of ecosystems, species and genetic varieties and ecological processes (including regulation of water flow and climate) which are vital for the support of all life on Earth and for the improvement of human social and economic conditions;
3. Protect genetic varieties and species which are vital in meeting human needs, for example in agriculture and medicine, and are the basis for human social and cultural adaptation in an uncertain and changing world;
4. Often are home to communities of people with traditional cultures and irreplaceable knowledge of nature (McNeely 1994).

b) Statutory authority under the Natural Area Reserves System

Hawaiʻi was one of the first states to set up a representative network of Reserves (Natural Area Reserves System 1992). The NARS was established by the State of Hawaiʻi in 1972 to protect natural resource and representative values in the face of rapid loss of native ecosystems. Because the biological wealth of Hawaiʻi was being depleted so rapidly by land use changes and the introduction of alien species, the designation of a representative system of protected areas sought to protect the best remaining examples of Hawaiian ecology and geology.

Since the enactment of legislation that established the Reserve system, the most unique and vulnerable Hawaiian ecosystems and geologic formations have been set aside for the enjoyment of future generations and to provide baseline examples against which changes in other unprotected areas could be measured (HRS §195-1). There are 19 Reserves (see Figure 3) on five islands, encompassing 115,446 acres of the state's unique and diverse ecosystems, established or expanded between 1973-2010 (Natural Area Reserves System website).

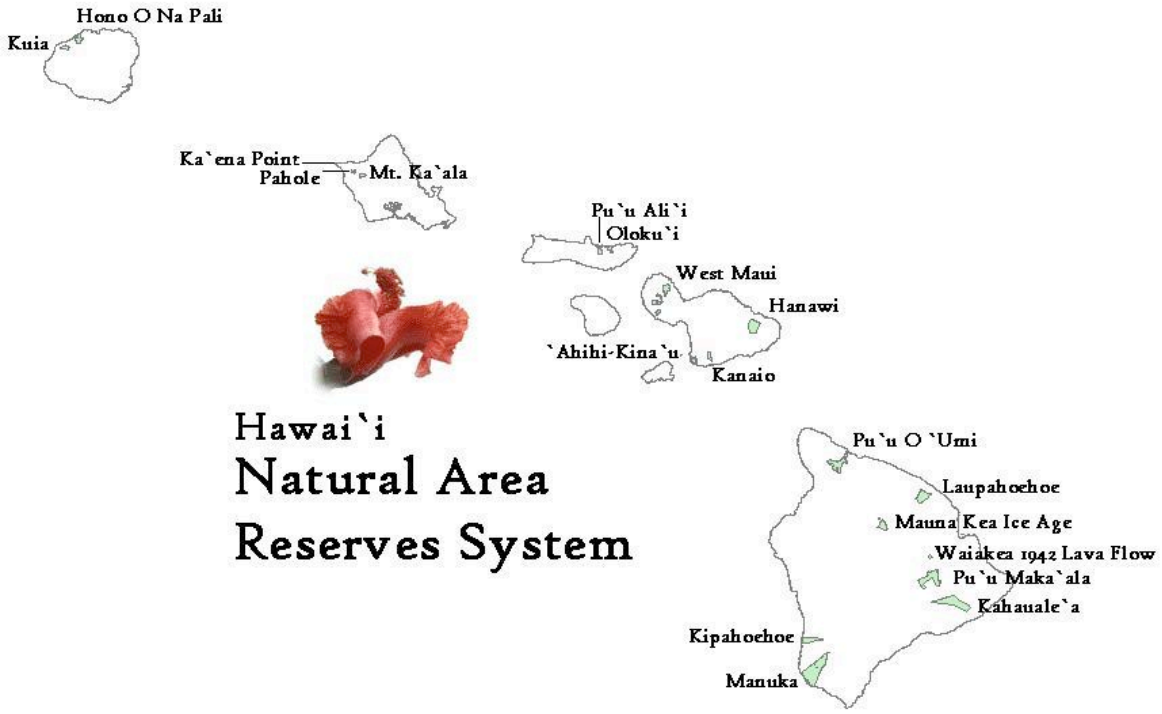

Figure 3. Map of the State of Hawaii's Natural Area Reserves System.

Natural Area Reserves are managed by the Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW), which has staff in each county. The system is overseen by the Natural Area Reserves System Commission (commission), who advises the Board of Land and Natural Resources (BLNR) and the Governor. Commission guidance to DOFAW occurs within a set of policies (Natural Area Reserves Commission 1997), a strategic plan (New Fields Companies, LLC 2008), and DLNR policy. The DLNR hierarchy of use states that the department must protect natural resources first, and then preserve compatible public uses, and only when the first two criteria are met, may they allow for compatible commercial use (DLNR 1997).

The Natural Area Reserves System provides permanent legal protection for conservation of resource values, one of the highest levels of legal protection for state managed natural areas in Hawai'i. NARS make up 11% of the one million acres under DLNR jurisdiction. Other types of designation include Wildlife Sanctuary and Forest Reserve. The Reserve system's mission is: "The Natural Area Reserves System exists to ensure the stewardship for Hawaii's unique natural resources through acquisition, active management, and other strategies." Under its mandate, the Natural Area Reserves System Commission and staff continue to consider nominations to add viable representative areas to the system. Many of the Reserves are remote and have few visitors. Conversely, Reserves located on the coast, are accessible and can be heavily used by the public: Ka'ena Point NAR on O'ahu and 'Āhihi-Kīna'u NAR on Maui.

c) Reserve management

The Reserve is managed by the DOFAW Natural Area Reserves System, which includes Maui and Oʻahu staff. The Maui-based NARs manager oversees the management and crews for nine Reserves on Maui and Molokaʻi. The lead ranger attends to day-to-day management concerns. The ʻĀhihi-Kīnaʻu NAR/Keoneʻōʻio Advisory Group (Advisory Group), formed in 2002, provides guidance to DLNR regarding the management of the Reserve and Keoneʻōʻio. DLNR sought the Advisory Group's advice on the use of kayaks and commercial activity in the area, and other matters of importance. Today, this Advisory Group is designed to reflect the diversity of stakeholder interests and is chaired by the DLNR Deputy Director. Members include educators, Native Hawaiian cultural practitioners and lineal descendants of the area, neighboring landowners, residents and visitor industry representatives, recreational snorkelers and fishers, conservation organizations, and scientists.

DLNR's Division of Conservation Resources Enforcement (DOCARE) is responsible to enforce all laws, rules and regulations in the Reserve. The statutory mandate (HRS Chapter 199) encompasses a wide range of law enforcement responsibilities that service all of DLNR.

Historic Preservation Division (SHPD) has a regulatory and support function in addressing management of the Reserve. SHPD must be given the opportunity to review all proposed actions that may affect historic properties in the area and give its written concurrence before these actions can proceed (§6E-8, HRS, and chapter 13-275, HAR). It is also the official repository of the State's inventory of historic properties and of archaeological and historical documents prepared to fulfill the requirements of the State's historic preservation law.

d) The Board of land and Natural Resources

Approval of this Plan by the Chairperson of the Board of Land and Natural Resources may trigger the following actions:

1. Preparation of regulatory compliance documents as required for implementation of management actions as outlined in the plan.
2. DLNR efforts to secure operational and planning funding for plan objectives.
3. Prioritized implementation of plan objectives by DLNR.
4. Periodic solicitation of requests for proposals or bids for implementation of plan objectives, including issuance of permits, licenses, or contracts in accordance with applicable Hawaiʻi Administrative Rules, as necessary.

Reserve budgets and staffing grew to meet the demand for greater presence and attention to human use pressures and resource management. Funds peaked with a four-year HTA grant from 2004-2008, but has since declined; current state funding has dropped to nearly 2005 levels. Even at peak levels, funding has been insufficient to meet Reserve management needs.

1.2.2 Management History

a) Management actions prior to Reserve establishment

ʻĀhihi-Kīnaʻu Natural Area Reserve has a long history of management investment by the community and DLNR, which began even prior to the establishment of the Reserve. As early as the 1960s, the Mākena to La Pérouse area was identified by the State as a key site for wilderness and marine protection as the development of Maui's coastlines began in earnest (Warnecke and Carl). In the late 1960s, citizens in the area cleaned up a dump site along the coastline and in a parking area near the Maʻonakala Village Complex. Mākena State Park was established in 1971.

In 1972 with the creation of the NARS, University of Hawaiʻi Cooperative Fisheries Biologist Dr. John Maciolek submitted a proposal to nominate the first Reserve to the Commission - from ʻĀhihi Bay to Cape Kīnaʻu. As a fresh water fish specialist, his aim was to protect the unique anchialine pool ecosystems of Cape Kīnaʻu, and direct preservation attention to the "high quality, little-used region of ʻĀhihi Bay and Cape Kīnaʻu" as "developers' blades moved southward along Maui's sparsely populated leeward coast" (Mack 1975). The proposal was strengthened by marine surveys conducted in 1970 and 1972 by DLNR, concluding that the area's coral reefs were rich in species diversity and abundance of both fish and invertebrate species (Division of Fish and Game 1972). In the following months, great debate commenced over what resources should be protected, what the boundaries should be, who should manage the area, enforcement, what activities should be allowed to occur, preservation of cultural sites, and road control and maintenance.

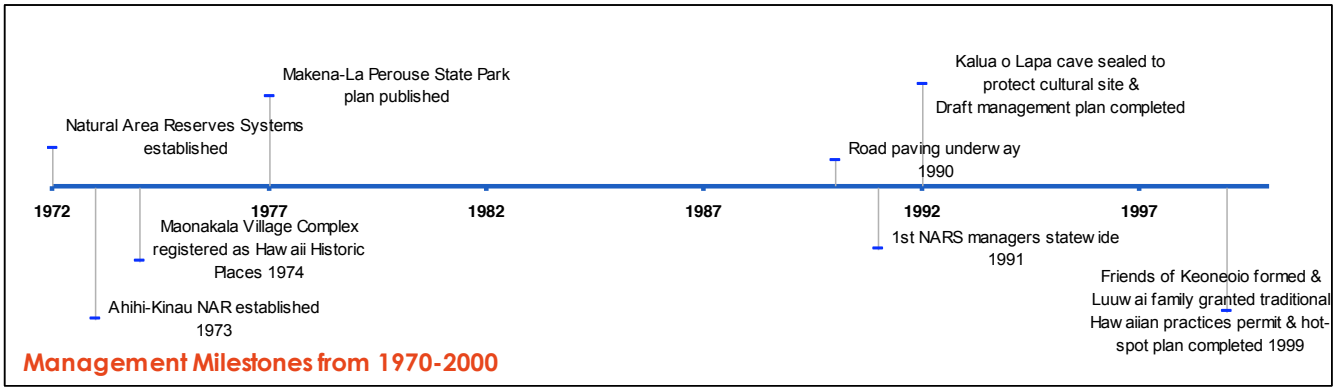

Figure 4. Reserve management milestones from 1970 to 2000.

b) Reserve established in 1973

Governor John H. Burns issued Executive Order 02668 establishing ʻĀhihi-Kīnaʻu Natural Area Reserve in June of 1973. Soon after, some of the same issues the Reserve grapples with today -- marine boundary buoys, enforcement, and interpretive literature -- came before the Commission and the Board.

Rapid urbanization of the Kīhei, Wailea and Mākena areas prompted the State to complete the 1977 Mākena-La Pérouse State Park study, which examined nine miles of coastline, including the Reserve, Mākena State Park and state unencumbered lands. The study recommended the preservation of Mākena-La Pérouse as a wilderness area, foreseeing an increasing need for

wilderness and recreation opportunities and resource preservation as the population of Maui continued to grow (H. Mogi Planning and Research 1977).

c) 1980s: New discoveries, resource damage, management actions

Between its designation and the late 1980s, several unique findings occurred in the Reserve which uncovered new shrimp species in anchialine pools (Maciolek 1983), and previously undescribed red seaworms in marine lava tube caves (Fielding 1994). Letters from concerned citizens and records of DOCARE officers during these years reported illegal activity including fishing and spear-fishing, collecting marine life, burning and abandoning of vehicles, target shooting, and flagging of archaeological sites. In order to protect resources from these types of activities, DOFAW made parking lot improvements at Keoneʻōʻio to accommodate 25 cars (reduced from a larger proposed size) and the construction of a lava rock wall to block off vehicular activity along the shoreline (Anon. 1998).

Several studies were published on the Reserve's natural resources in the 1980s; a 1985 University of Hawaiʻi Marine Options Program survey (Bass and Teshima 1985), and a survey of terrestrial resources by The Nature Conservancy's Hawaiʻi Heritage Program (1989), which included survey reports and recommendations on the protection of the Reserve's anchialine pools (Chai 1988) and terrestrial and lava tube arthropods and insects (Howarth 1988).

Although no formal user surveys were conducted during the 1970s-1980s, Reserve managers estimate that visitor numbers were significantly lower than current levels due to the condition of the road leading to the Reserve. The road was paved and widened in several phases between the mid 1980s to mid 1990s, thereby increasing vehicular access. In 1993, the road was widened at the far end of the Mākena-Keoneʻōʻio Government Road within the Reserve where the paved road ends (Wong 1993). It is unclear as to the exact date that the road was completely paved, however, it is clear that paving the road increased visitation to the area (Vann 2005). The road is currently maintained by the County of Maui, and ownership and control of the 20-foot wide easement is under dispute as to whether it is held by the county or state with a memorandum of agreement pending.

d) 1990s-2000's: Kalua O Lapa Cave sealed, *ahupuaʻa* tenant rights upheld, and commercial activity halted.

After vandalism and removal of cultural items and human remains from lava tube caves containing Native Hawaiian burials near Kalua O Lapa, the cave was permanently sealed in 1992. The concrete seal was reinforced again in 1994 under the direction of the Commission and the Maui Island Burial Council (Anon. 1998).

In 1997, the Luʻuwai family of Mākena requested access to the Reserve for the purposes of teaching subsistence fishing to their children in their ancestral grounds. The Commission formed a working group that studied the request and consequently the family was granted a permit in 1999 (ʻĀhihi-Kīnaʻu Advisory Group 1998). Activities are strictly regulated by permit conditions and the permit must be renewed annually.

The Division of Aquatic Resources (DAR) conducted an underwater survey of the marine area of the Reserve closely replicating the 1972 study (Division of Aquatic Resources 1998). They

concluded that a lush finger coral bed found in 1972 had been heavily damaged by storms but that shoreline fish, other bottom dwelling species, corals and ʻ*opihi* (intertidal-dwelling limpets) appeared to be doing well. In 1998-99, growing concerns including traffic, crowding, illegal activities, commercial activity, resource degradation, user conflicts, and public safety prompted the NARS Commission and the Department of Land and Natural Resources to focus attention on the Reserve as one of 25 "Hotspots" statewide. The 1998 Sustainability Hot Spot Plan provided an estimate of what would be needed to adequately manage the Reserve; it included a budget of $2.7 million dollars and a staff of eight.

In 1999, the Hawaiʻi Institute of Marine Biology selected two sites in the Reserve to add as permanent survey sites in the Coral Reef Assessment and Monitoring Program, or CRAMP (Jokiel et al. 2004). These reef and reef fish surveys, conducted by DAR, continue today. CRAMP data help managers to understand how the reef is doing over time and in comparison to other sites, which in turn guides management actions.

Increasing unregulated commercial use in the Reserve was of great concern at this point, with letters on the record to the DOFAW since 1992 (Evanson 1993). Commercial use, illegal activity, road traffic, kayakers, and divers were all on the rise. There were concerns regarding how the resources should be better monitored, how information was being disseminated, and addressing the increasing need for trash and sanitation management. Hawaiʻi Wildlife Fund, who had been recording data on human-dolphin interactions in neighboring Keoneʻōʻio since 1998, expressed concern that the resources were being "loved to death." During this time, a coalition of interested citizens formed a group called the Friends of Keoneʻōʻio, whose activities brought media attention to the area. By 2003, the issues at Keoneʻōʻio and the Reserve became so notorious that in a short span of three months, more than 21 articles were published in Maui papers (Vann 2005).

As early as 2000, Hawaii Community Foundation funded Hawaii Wildlife fund to produce a naturalist training manual. They began training volunteers to interact with visitors, showing that 90% of area visitors discovered the Reserve through the publication *Maui Revealed* and their primary activity was snorkeling (CSV Consultants and Hawaii Wildlife Fund 2007). *Maui Revealed* also identified commercial activities taking place in the area such as hiking and kayaking. The Advisory Group took up the issue and wrote a November 2004 letter to *Maui Revealed* unsuccessfully requesting that they remove references to the Reserve from their popular tourist publication in order to reduce human impacts to resources.

In 2001, a partnership of Maui DLNR officials, the nonprofit, Maui Mālama Pono, and the Rivers, Trails, and Conservation Assistance (RTCA) Program of the National Park Service formed the Keoneʻōʻio- Kanaloa Working Group to examine preservation and management issues in the coastal area from Keoneʻōʻio southward to Kanaloa (Vann 2005). The group, composed of 30 participants which included landowners, managers, neighbors, commercial and private users, and community stewards, accomplished the following actions: 1) Developed a consensus statement of desired conditions for the area, and the associated responsibilities of stakeholders if those conditions are to exist; and 2) Proposed 20 emergency measures, divided into immediate, six-month, and one-year time frames (NPS 2003). Several of these measures were implemented, including the fencing and gating of the road into La Pérouse Bay on ʻUlupalakua Ranch lands, enforcement of night time "raves" in the bay, an increase in visitor outreach to

reduce resource damage at the Keoneʻōʻio parking area, preservation of an archeological site, and increased pressure on DLNR to address the commercial kayak activities.

During the same time frame, the area coastline was nominated to be a National Seashore, and Mary Evanson, a long-time resident and activist on Maui, and president of the Friends of Haleakalā National Park**,** was pushing for La Pérouse Bay to become a National Park. After many years of observing state efforts to protect the Reserve fail, she concluded it could be better managed under the federal government. In February 2001, Congresswoman Mink initiated a National Park System feasibility study for the area from Keoneʻōʻio to Kanaloa Point (NPS 2003). A reconnaissance survey of the shoreline, offshore waters, and cultural sites was conducted between Keoneʻōʻio and Kanaloa Point. The study did not include the NAR. While the study found that the area did not meet National Park criteria, it found that the many natural and cultural resources needed better management immediately.

In response to the public's demand for regulation of unregulated commercial kayak operations, DLNR conducted a rapid assessment (DLNR 2003) to determine impacts that occurred to the resources due to these activities. The report recommended the following for the Reserve: ban or carefully limit both commercial use and kayaking, increase signage and staff presence, limit the number of users, and charge a parking/user fee. In September 2003, DLNR formed the ʻĀhihi-Kīnaʻu NAR/Keoneʻōʻio Advisory Group to advise the department on matters of importance such as unregulated commercial activity. The Advisory Group consisted of representatives from the commercial kayak industry, fishermen, cultural practitioners, residents and scientists, some of whom were active in the Friends of Keoneʻōʻio. In December, DLNR held a public informational meeting attended by 150 people supporting a ban on commercial activity in the NAR. Following Advisory group and Commission recommendations, commercial activity was banned in the area in April 2004 (Evanson 2005).

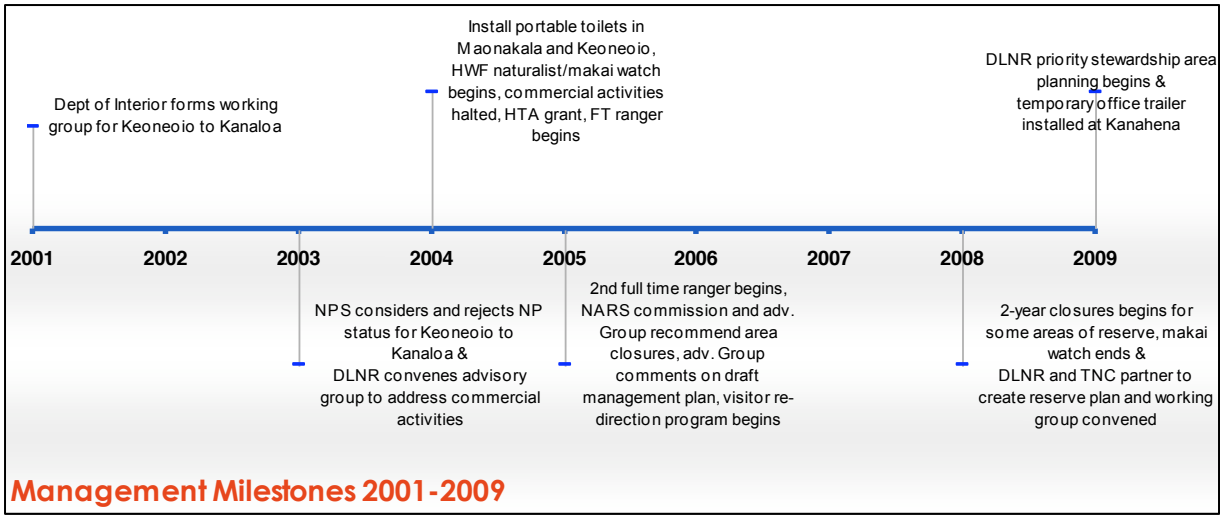

Figure 5. Reserve management milestones from 2001 to 2009.

e) 2004-2008 New era of increased management presence

Between 2004-2007, with the support of a grant from the Hawaiʻi Tourism Authority (HTA), the ʻĀhihi-Kīnaʻu NAR/Keoneʻōʻio Advisory Group, and community groups, the DLNR took

several management actions designed to reduce the impact of large numbers of visitors: 1) hired full-time Reserve Rangers; 2) provided support to Hawaiʻi Wildlife Fund for an education station, naturalists, and human use surveys; 3) installed portable toilets, trash receptacles and information signs; 4) conducted an environmental assessment of potential boundary buoys; and 5) contracted an archeological survey and a marine survey of the coastal resources and user impacts in the nearshore environment.

The HTA funding created the first full time ranger position specifically dedicated towards onsite presence in the Reserve. Rangers were hired to interact with the visitors, survey resources, and document and report illegal activity. The first ranger was hired in 2004. It is important to note that rangers do not have enforcement power; they must contact DOCARE or MPD for any enforcement action to take place. Prior to the establishment of the Ranger Program, DOCARE was the primary agency for providing patrols and surveillance, education, and community networking towards DLNRʻs efforts to protect this area.

With the hiring of a second full time ranger in 2005, the Reserve instituted a new program in collaboration with Hawaiʻi Wildlife Fund, to direct users away from sensitive resource areas and toward places in the Reserve that were safer and provided better quality experiences. In addition, more than 150 boulders were placed along the road to ensure traffic flow along the narrow road and emergency vehicle access. This step was also taken to eliminate illegal activity (camping, fires, littering, and drug use) that was occurring along the roadside at night. Between 2004-2008, on-the-ground personnel grew to a staff of five rangers.

In 2000, Hawaiʻi Wildlife Fund (HWF) produced a naturalist training manual and began training volunteers to interact with the public to keep the behaviors of visitors from harming resources (Olsen and Bernard 2007) at Keoneʻōʻio. Between 2004-2008, Hawaiʻi Wildlife Fund coordinated a "Makai Watch"(http://Hawaiʻi.gov/dlnr/dar/coral/coral_las_makaiwatch.html) education station at Maʻonakala parking area in the Reserve, placed a roving naturalist at Keoneʻōʻio, and collected human use data.

From December 2006–June 2008, the Action ʻĀhihi stewardship outreach program, in collaboration with Hawaiian Islands Humpback Whale National Marine Sanctuary and others under a DAR Makai Watch grant, established a volunteer based user education program at Kanahena Cove.

The Reserve rangers and Hawaiʻi Wildlife Fund worked with the Division of Conservation and Resources Enforcement (DOCARE) and the Maui Police Department (MPD) to increase enforcement attention to the Reserve and Keoneʻōʻio. The collaborative work between the parties provided faster response time and greater enforcement attention to the area. Enforcement issues addressed by DLNR staff included removing a woman living in a lava tube in the Reserve, and citing a commercial operator for anchoring and coral damage.

NAR Rangers interact with the public, answering questions, addressing concerns, and assisting the public with compliance with NAR rules. However, for enforcement of violations, Rangers call upon DOCARE officers to enforce all DLNR and NAR rules, and Maui Police Department (MPD) to address other illegal activity. From 2009-2010 the level and intensity of management of the reserve was five full-time Rangers, providing some staff presence seven days a week, 365 days per year, 16 hours per day in two daily shifts.

f) Recent studies conducted

Between 2004-2008, the Hawaiʻi Tourism Authority (HTA) also funded several studies to inform management planning and action. Hawaiʻi Wildlife Fund conducted several different human usage studies annually from 2004-2007. A Cultural Resource Management Plan (CRMP) was completed in 2007 (Desilets et al. 2007). The purpose of the CRMP was to recommend a course of action to protect the cultural sites, with attention focused on the corridors of heavy public use rather than the whole Reserve. The survey concluded that as a whole, most sites are in relatively good to excellent condition, however high use of the trails to Kalaeloa (aka "Aquarium") and Mokuhā (aka "Fishbowl") resulted in near complete disintegration of some archaeological features. It also noted evidence that sites were being used as toilets.

A set of marine assessments rounded out the studies funded by the HTA grant. They were 1) Human Impact Evaluation on Nearshore Environments (Rogers et al. 2008); 2) Compilation of Existing Information on the Marine Environment (Rogers et al. 2008); and 3) Biological Assessment of ʻĀhihi-Kīnaʻu NAR (Rogers et al. 2009).

The Fish and Wildlife funded study (Brock 2004) surveyed the anchialine pools of the Reserve noting that they are the premier example of anchialine resources in the nation. Protected by isolation and lack of development, the pools still experience serious degradation as evidenced by footprints in the pool sediment, the taking of shrimp, and human waste. The study recommends that visitors should not be allowed within 100 m of any pool and that staff block or redirect all trails that come within this distance from anchialine pools.

In 2007, the U.S Army Corps of Engineers funded a site inspection and report on Kanahena Point, one of four Maui sites used for bombing target practice by the Navy from 1945 through 1946 (Parsons 2008). Based on the remnant munitions found during site inspection, the report recommended that a feasibility study be conducted for treatment of munitions and explosives of concern. The Army Corp will begin the process to consider how these concerns will be addressed in late 2010.

g) Recent rules changes and buoy and road issues near resolution

During the study period of 2004-2008, anchialine pools, nearshore marine resources, geology, and cultural sites all showed impacts from unregulated human use (Matt Ramsey pers. comm.). Many of these impacts were due to unintentional trampling from people wandering through the lava in search of popular snorkeling destinations; other damages were due to poaching of marine resources, graffiti, and other illegal activity. Public safety was also a concern for managers as visitors were often injured on the remote, uneven and rough terrain of the coastal lava fields. Minor injuries such as scrapes from falls were common. In addition, there were also helicopter evacuations, emergency medical assistance responses, and visitor deaths.

In 2005, the Advisory Group and NARS Commission requested that DLNR temporarily close portions of the Reserve to prevent further resource damage. However, the Attorney General's Office concluded that it was not currently within the legal power of the Commission or the Board to close off portions of an entire Reserve unless it was a matter of public safety. The requested closure would require a rule change. Acting on this guidance, in June 2006, staff held

hearings simultaneously on four islands to present rule modifications in Natural Area Reserves. New rules went into effect in January 2007 (HAR § 13-209-1). A total of 11 rules were modified or added including the ability to create and enforce visiting hours and close a Reserve or portion of a Reserve for up to two years.

On the authority provided in the rule changes, the Advisory Group and NARS Commission recommended the BLNR adopt a two-year action plan, August 1, 2008– July 31, 2010 (NARS 2008). The plan called for 90% of the land portion of the Reserve to be closed off to the public leaving the coastal areas near the entrance in ʻĀhihi Bay open for public access during visiting hours. These areas were to remain open for the public because the safer water entry areas and well-marked paths allowed users to enjoy the Reserve without damaging resources or compromising safety. The Action Plan outlined specific baseline surveys that were to be performed during the closure. After being approved by the BLNR in May 2008, access restrictions were in effect from August 1, 2008-July 31, 2010. In June 2010 the NARS Commission recommended and the Board approved a second staff request for access restrictions for the period August 1, 2010- July 31, 2012.

In January 2008, a final (unpublished) environmental assessment to install buoys along the marine boundary of the Reserve was completed (NARS 2006, 2008a). The assessment included comments collected during a pre-consultation and public comment process beginning in 2004. The benefits of the buoy installation included increased compliance with no-take and no motorized vessel rules in the Reserve. Drawbacks included selection of the appropriate type of buoy for the site, actual costs, and installation methods.

Between 2008-2010, the County of Maui sponsored discussions to resolve the road ownership with the State drafting a memorandum of agreement documenting the roles and responsibilities of each party regarding the government road in the Reserve. Once the agreement is completed and in place, control and maintenance of the road should be resolved for implementation of management strategies.

h) 2008 -2010: Management planning process

This management plan builds upon the process started in 2005 with the 2005 Draft Management Plan developed by NARS staff and submitted to the Advisory Group for review and comment. In 2008, The Nature Conservancy (TNC) and DLNR partnered to complete the draft management plan for the Reserve using Conservation Action Plan (plan) principles[7]. This plan was developed by TNC and NARS staff together with a working group, consisting of committed volunteers from the advisory group and the public, DLNR staff, and agency partners. The working group met between 2008-2010 in five day-long plenary sessions and ten small group meetings to develop and provide input to the plan.

This plan recognizes the substantial effort that has gone into caring for the Reserve since its inception, and as relevant, incorporates recommendations and priorities from the 1992 Draft Management Plan, 1998 Sustainability Hot Spot Plan, 2005 Draft Management Plan, and other site specific reports which offer management recommendations. Many of the recommendations have similar themes as can be seen in Table 2, a summary of recommended management actions since 1977.

This current Reserve management planning process is concurrent with three adjacent or regional planning processes:

1) DLNR Stewardship Management Area Priority: In 2007, the Reserve was one of five areas selected statewide as a DLNR Stewardship Management Area Priority, to implement the Ocean Resources Management Plan. Maui divisions of DLNR are working together to achieve inter-departmental, place-based collaboration in the area from Maluaka (Mākena Beach and Golf Resort) to Cape Hanamanioa. Led by the Division of Forestry and Wildlife, this multidisciplinary team includes Commission on Water Resource Management, and the Divisions of Aquatic Resources Conservation and Resource Enforcement, Historic Preservation, Land Division, Office of Conservation and Coastal Lands, and State Parks.

2) Adjacent designation: The coastline southwest of ʻĀhihi-Kīnaʻu to Kanaloa Point has been identified as biologically important by the Natural Area Reserves System Commission for its coastal strand and lowland dry vegetation, anchialine pools, and offshore ecosystems. This area also contains important archeological sites. The Division of Forestry and Wildlife has been conducting surveys and meetings to discuss protective designation of these resources which are currently unencumbered lands in the conservation district (Emma Yuen pers. comm. 2009). There is also interest in DOFAW to designate parts of Kanaio as a game management area.

3) Update the 1977 La Pérouse-Mākena State Park Plan: State Parks Division is in preliminary discussions to update the 1977 La Pérouse-Mākena State Park Plan. Discussions are with Dowling Company; updating the plan was part of the conditions in their change in zoning approval (Phil Ohta pers. comm. 2009).

In summary, the Reserve has moved through several stages of management planning, from an agency and partner-oriented process to one inclusive of stakeholders. With the completion of this plan, agencies, partners and stakeholders will be better prepared to protect the resources of ʻĀhihi-Kīnaʻu, work with visitors and users to ensure enjoyment and safety for all, as well as engage in adjacent and regional planning processes that help reach Reserve goals and support compatible adjacent uses.

Table 2. Summary of the management recommendation from various plans and reports from 1977 to 2008.

Management recommendation / Source of recommendation	Monitor resource health, threat abatement, and or management effectiveness	Maintain adequate staff, volunteer and enforcement presence	Address illegal fishing and boundary issues	Control access and use to prevent resource degradation at vulnerable sites	Charge a user or parking fee	Increase outreach (i.e. signage, interpretation facilities)	Improve trails; requirement to stay on trails, and or guided hikes	Protect and interpret cultural sites	Prevent and or control alien species	Other recommendations
Mākena-La Pérouse Plan 1977				X		X		X		Provide buffer area; Prevent runoff Improvements
Chai 1988	X	X	X	X		X	X			Litter control
Howarth 1988	X			X			X	X	X	Litter control
Draft Management Plan 1992	X	X	X	X		X	X			
Hot-Spot Sustainability Plan 1999	X	X	X	X		X		X	X	Infrastructure improvements; Preserve wilderness experience
Brock 2004	X	X		X		X	X		X	Infrastructure improvements
Draft Management Plan 2005		X	X	X	X	X	X			Parking and vehicle controls; safety; on site manager; communications
Gulko 2005		X	X		X	X				Parking controls; Limit number of vehicles
Vann 2005	X	X	X	X	X	X	X	X	X	Native plant protection; Litter control; Regional planning
Desilets et al. 2007	X	X		X		X	X	X		
Rogers 2008	X			X		X	X			Parking control

1.3 Critical Threats

a) Threats identified

Through the collaborative management planning process involving stakeholders and agency managers, twenty-four threats to Reserve resources have been identified. These are grouped under four categories: 1) Human uses; 2) Alien species; 3) Land-based impacts; and 4) Global impacts. These categories correspond with a world-wide effort to standardize planning language in conservation, the Conservation Measures Partnership (CMP), discussed further below. Some of these threats have an impact on just one type of resource in the Reserve, however, many of them affect multiple Reserve resources. Each of these threats has been ranked using a process that identified what threats affect which resources and their level and type of impact. The resulting ranking is important because in any given project area, there are always many activities that could be undertaken. The purpose of identifying the most critical threats is to direct energy and resources to reduce them.

These rankings are not absolute, as they are ever changing. The severity, scope, contribution, and irreversibility can each be affected by a management action, change in access, introduction of a disease or innumerable other factors. The threat analysis in this plan is a snapshot in time of the period between 2008-2010. During much of this time, human access to the resources of Cape Kīnaʻu was restricted. Relative threat ranking will need to be adapted by managers in real time as management actions reduce threats and new threats emerge.

Threats listed here take into account potential as well as existing impacts. For instance, potential, or preventable threats, such as intentional introduction of alien species, may be listed as high, or higher than an existing threat. Some of the most effective conservation actions are those aimed at stopping threats that are not a problem now, but have the potential to cause problems unless pre-empted.

Threats to ʻĀhihi-Kīnaʻu NAR resources are grouped into four categories. Each individual threat in the category is ranked very high, high, medium, or low. The ranking process considers the relationship of the threat to the resources, historical impacts, severity, scope, contribution, and irreversibility. The ranking can be seen in Tables 5-8.

b) Using the Conservation Measure Partnership system

World-wide much work is being done by conservation organizations to build a common language and nomenclature to improve the practice of conservation. These groups are working together to describe the problems they are facing and the solutions they are using. Unified classifications can help managers better understand their site, compare data across sites, and accurately compare notes and share lessons learned with others in similar situations. This common language of threats increases the chances of designing and implementing effective monitoring and evaluation systems and ultimately, enhancing program and project design and implementation for successful biodiversity conservation. To utilize this unified system from The Conservation Measures Partnership (CMP), each one of the four Reserve threat categories references the CMP threat taxonomy (http://www.conservationmeasures.org/CMP/).

Table 3. The Reserve threat categories compared to international threat categories from the Conservation Measures Partnership (CMP).

	ʻĀhihi-Kīnaʻu NAR Threat Category	Associated Conservation Measures Partnership (CMP) Threat Category
1	Human use (H)	*CMP 6. Human Intrusions and Disturbance; CMP 5. Biological Resource Use*
2	Alien species (A)	*CMP 8. Invasive and Other Problematic Species and Genes*
3	Land-based impacts (L)	*CMP 1. Residential & Commercial Development; CMP 9. Pollution; CMP; 7. Natural Systems Modification*
4	Global impacts (G)	*CMP 11. Climate Change & Severe Weather*

1.3.1 Human use

a) Levels and impacts of human use

Surveys of human use patterns (2002-2007) report an average of 700 people per day or 250,000 people per year visit the Reserve (CSV Consultants and Hawaiʻi Wildlife Fund 2007) and neighboring Keoneʻōʻio (Hawaiʻi Wildlife Fund 2006), ranking the area as one of Maui's most sought after visitor locations (Table 4). Trampling is the most common source of damage from people. Trash and waste, vandalism, poaching and entry into restricted sensitive areas also contribute to resource degradation.

Table 4. Comparison of number of annual visitors at some of Maui's popular destinations.

Natural and Marine Attractions	Annual average visitors*
Haleakalā National Park	1,600,000
Molokini Marine Life Conservation District	400,000
ʻĀhihi-Kīnaʻu Natural Area Reserve	250,000
Maui Ocean Center	200,000
Honolua Marine Life Conservation District	160,000
Whaler's Village Museum	160,000
Atlantis Submarines	100,000

*References for Table 4: Visitor annual estimates from Haleakalā National Park pers. comm. 2007, Hawaii's Local Action Strategy to Address Recreational Impacts to Reefs 2005, Hawaiʻi Wildlife Fund reports, Maui Ocean Center pers. comm. 2007, Maui County Data Book 2006, Atlantis Submarines pers. comm. 2007.

The high volume of visitors to the Reserve results in crowding, traffic and parking issues and a general lack of awareness of how to help protect and preserve natural resources and of Native Hawaiian and regional culture and history. Impacts to resources include destruction of archeological structures, rock removal and vandalism; poaching of marine species; trampling; waste and trash; motorized vessels and anchoring; new trails and damage to existing trails; and protected species harassment. Protected species harassment specifically includes disturbance of endangered and protected marine animals: Endangered Hawaiian monk seals disturbed while resting and molting on shore; basking sea turtles disturbed while resting on shore; spinner dolphin resting period disturbed by swimmers; and swimming sea turtles chased and touched by swimmers. See Table 5 for prioritization of human use threats to resources.

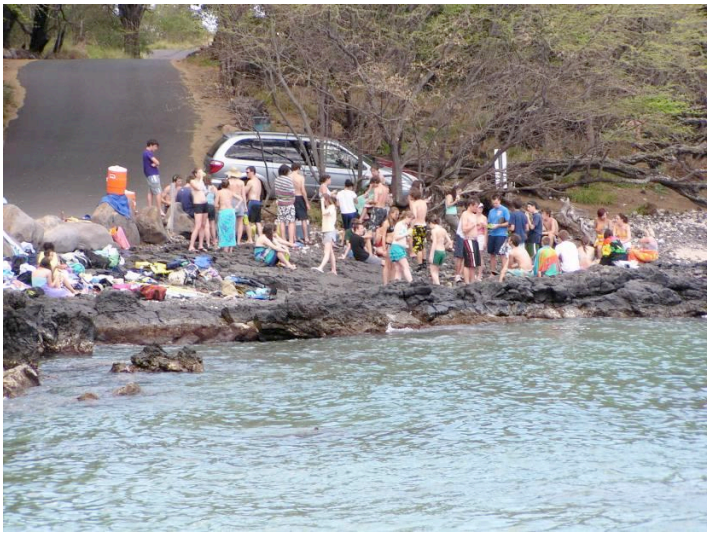

Figure 6. High visitor use at Kanahena Cove (photo by Matt Ramsey).

b) Locations and patterns of human use

Approximately 75 percent of Reserve visitors are from outside the state and 25 percent are local residents (both referred to as visitors). Overall, more visitors are present on weekends than weekdays. More than half of visitors are interested in snorkeling and ocean wildlife viewing. Other visitors are interested in the geology and lava flows, hiking opportunities, beach going, and seeing La Pérouse Bay, while some are lost or simply exploring (CSV Consultants and Hawaiʻi Wildlife Fund 2007).

Up until the implementation of a two-year action plan in August 2008 (Natural Area Reserves System 2008), damage to natural and cultural resources along trails across Cape Kīnaʻu was the primary threat to resources. Impacts included waste, trash and trampling in anchialine pools, cultural sites and sensitive tidal pools, and trampling and vandalism to geologic and cultural sites and historic Hawaiian trails. Visitation in the Cape Kīnaʻu area ranged from 20-300 people per day (NARS unpublished data) between 2005-2008. A closure was approved by the BLNR in August 2008 for a two-year period and was extended for an additional two years in June 2010. The temporary restricted access rules of Cape Kīnaʻu and Kalua O Lapa protect sensitive resources vulnerable to human impacts. During the closure, resources and human use are being monitored to gather information for future management action. See Figure 7, August 2008-2010 and August 2010-2012 restricted access zoning.

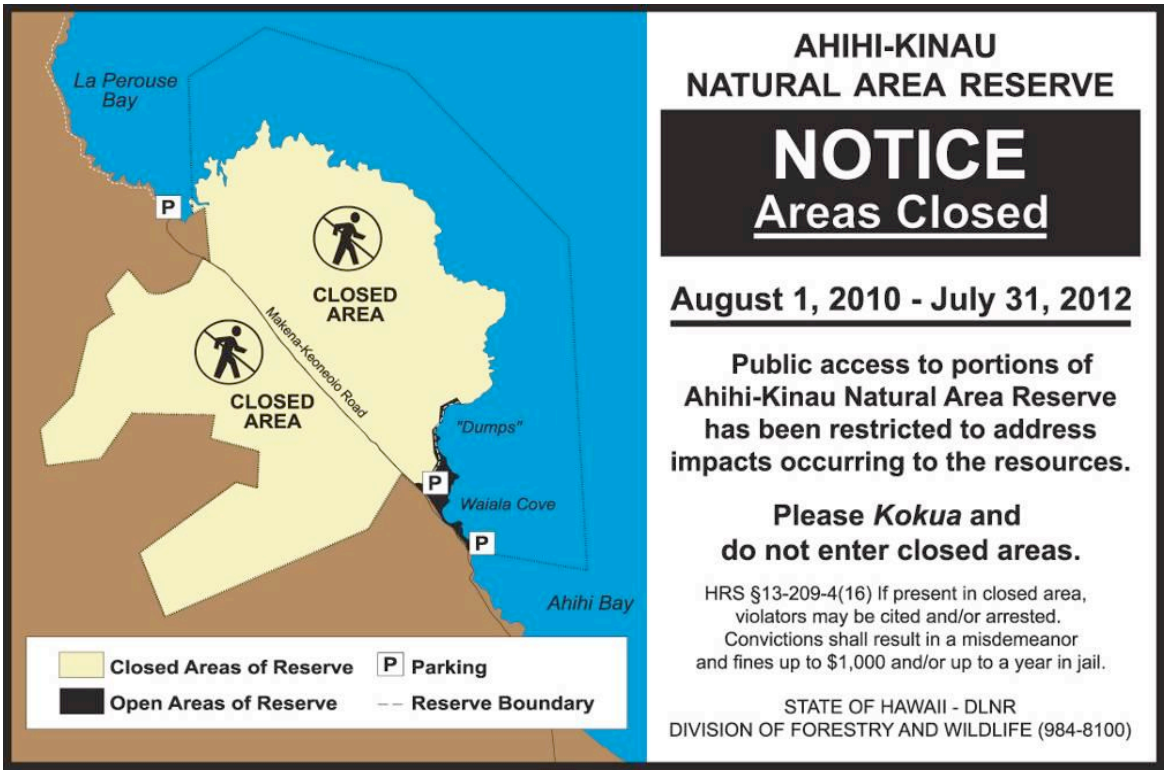

Figure 7. Map of August 2008-2012 open access and restricted access areas.

Since the two-year access and use restrictions beginning in August 2008, use of the Reserve occurs primarily from three main areas: 1) Kanahena Cove, 2) The Reserve's Kanahena Parking Area, and 3) Keoneʻōʻio/La Pérouse Bay. Visitors park either at the Reserve entrance, where there is space for only a few cars, the Reserve's Kanahena Parking Area, or Keoneʻōʻio/La Pérouse Bay, which is outside and adjacent to the Reserve. Closed trailheads are clearly marked. Parking areas are unregulated.

c) Safety and facilities

Public safety concerns include injuries from lava and coral, drowning, getting lost, life-threatening personal health emergencies, evacuations, deaths, car breakdown, lockout, theft, and poaching of deer. Current infrastructure includes two unpaved parking areas with portable toilets (one in the Reserve's Kanahena Parking Area, and one outside of the Reserve at Keoneʻōʻio/La Pérouse Bay). A portable office trailer in the Reserve's Kanahena Parking Area is expected to be staffed during business hours seven days a week beginning in 2010. Signage is provided at the Reserve's entry, Kanahena Parking Area, Keoneʻōʻio and all along the road. Traffic issues include two-way traffic on the one-lane undivided, unimproved road where there are few spots to pull over, and excessive traffic on a single lane road. Traffic backs up through Kanahena Cove and in Keoneʻōʻio where the pavement ends and parking is limited. Lack of clarity on whether the road belongs to the county or state has left some road issues unresolved.

d) Illegal activities

Enforcement data from Reserve rangers suggests poaching of resource fish species and intertidal species is the most prevalent resource-related violation. Resource-related (approximately 40% of reported incidents) and non-resource related violations are on a downward trend, from peak levels during 2005-2006 (NARS unpublished data)). The decrease is attributed to an increase in on site presence of rangers. According to DOCARE, the most prevalent illegal activity is entry by boat into the Reserve (DOCARE unpublished data). The most common incidents for Maui Police Department response is vehicle break-ins.

Table 5. Threats to resources from human use.

	⇒Targets⇒ ⇓Threats⇓	Targets							
		Anchialine pools	Cultural landscape	Coastal marine	Coral reef	Lava flows	Native shrublands	Wilderness qualities	Summary Threat Rating
Threats	H1: Vehicular traffic (noise, emissions, congestion, wear and tear, off-road vehicles)		High			Medium	Low	High	High
	H2: Destruction of resources (damage to formations, structures, rock removal, spray paint, vandalism)	High	High			High			High
	H3: Illegal harvest of marine species			High	High				High
	H4: Human trampling	Very High	High	Medium	Medium	Medium			High
	H5: Human waste and trash	Medium	Medium					Medium	Medium
	H6: Motorized ocean vessels in the reserve; anchoring				Medium			Medium	Medium
	H7: New trails across lava flows and damage to existing trails	Medium	Medium			Medium			Medium
	H8: Unexploded ordinance	Low	Low	Low	Low	High			Medium
	H9: Protected species harassment				Medium				Low

*Indirect threats: 1) too many people, 2) lack of visitor awareness of reserve resource

1.3.2 Alien Species and Other Biological Threats

a) Critical threat in Hawaiʻi

The introduction and spread of alien species has contributed significantly in the past and is now the predominant cause of biodiversity loss in Hawaiʻi. The silent invasion of Hawaiʻi by insects, pathogens, weeds, and other pests is the single greatest threat to Hawaii's economy and natural environment, and to the health and lifestyle of Hawaii's people.

Hawaiʻi, with far above-average vulnerability to invasions (Loope and Mueller-Dombois 1989; Denslow 2003), is also a major international hub of commerce. It is by far the U.S. region most damaged by alien species, with large numbers of and serious impacts from vertebrates, invertebrates, diseases, and flowering plants (OTA 1993).

b) Alien species in the Reserve

Alien species threats specific to the Reserve's resources are summarized in Table 6. They include the introduction of new alien species; competition with existing introduced plant species; browsing, grazing and trampling by introduced hoofed animals (deer, goats, pigs); introduced insects; predators on native plant seeds; woody plant species growing around anchialine pools and archeological sites; marine alien fish and invertebrates; and water and seabird predators. Nearly every Reserve resource is affected by alien species or other biological threats. The degree of threat varies with the species and the resource.

Figure 8. Introduced feral goats consume both native and non native vegetation (photo by Joe Fell-McDonald).

c) Alien species on land

Some well-documented threats, such as aquatic alien species in anchialine pools, have decimated the native biota in many of the pools on Hawaiʻi Island, elevating this potential threat to the highest level. Anchialine pool surveys indicate that Reserve pools are currently free of introduced aquatic species.

Alien plants around the anchialine pools would completely fill these unique systems if not for weed control intervention. Nesting native waterbirds in the pools are vulnerable to predators like cats, dogs, rats and mongoose. Nesting seabirds are vulnerable to the same introduced predators.

Coastal dry shrubland and forests are inundated by very high levels of browsing by deer and goats which gives the alien plant species a competitive advantage. For example, one of the only native plants surviving in the Reserve under this stress is the flowering shrub, *maiapilo* which, by virtue of its chemical composition is completely inedible by even the hardiest goat. A fenced enclosure next to the reserve has kept a small area ungulate-free for a number of years now, and flourishes with native plant species, an indication of the kind of recovery of native terrestrial resources is possible if ungulate browsing were addressed.

In the early 2000s, the inadvertent alien introduction of the Erythrina gall wasp (*Quadrastichus erythrinae*), decimated a keystone species of the native low elevation forests, the *wiliwili* (*Erythrina sandwicensis*) tree, by consuming its leaves. A parasitoid bio-control agent was released in the hopes of controlling the gall wasp in 2009. The State Department of Agriculture has seen some early signs of success of the biocontrol, as the *wiliwili* trees regain leaf production.

d) Alien species on nearshore and coral reef ecosystems

The introduced fish, roi (*Cephalopholis argus*), is also thought to be a threat to Reserve reefs. Roi were introduced to Hawaiian waters by the state in the 1950s to enhance local fisheries. Hawaii's Division of Aquatic Resources (DAR) recently documented that roi populations have increased 15-fold since the 1980s in the main Hawaiian Islands, and have become the dominant nearshore predator on Hawaii's reefs where they consume small native fishes. A University of Hawaiʻi study estimated that in a three-square-mile area off the Kona Coast of Hawaiʻi Island, the abundant roi eat 99 tons of reef fish annually — the equivalent of 8.2 million fish. Two other introduced fish are present in the reserve, taʻape or blue lined snapper (*Lutjanus kasmira*) and toau or blacktail snapper (*Lutjanus fulvus*).

e) Other biological threats

Other biological threats include crown-of-thorns sea stars, coral disease and fish disease. Crown-of-thorns sea stars (*Acanthaster planci*) caused documented damage to Reserve reefs between 1999-2006 when coral cover at Kanahena Point declined from 23-26%. (Rodgers et al. 2009). Crown-of-thorns sea stars are still present in the Reserve, however, the extent of current impact is observed to be less than previously recorded.

Coral disease was documented by University of Hawaiʻi researchers in a Reserve tidal pool in 2009. In 2010, the disease increased its extent and effect on the *Montipora* sp. coral colonies found in the pool. Monitoring of the corals is ongoing. Fish disease has also been documented for the Reserve's most abundant reef fish, kole or yellow-eye surgeon fish (*Ctenochaetus strigosus).*

Table 6. Threats to resources from alien species and other biological threats.

	⇒Targets⇒ ⇓Threats⇓	Targets							
		Anchialine pools	Cultural landscape	Coastal marine	Coral reef	Lava flows	Native shrublands	Wilderness qualities	Summary Threat Rating
Threats	A1: Potential of alien species introduction	Very High	Low	Medium	Medium	Low	High	Low	High
	A2: Impact of existing introduced species(woody plant species growing around anchialine pools and archeological sites, native plant s competing with alien plants, introduced fish species, e.g. roi, ta'ape)	High	High	Medium	Medium	Medium	High	Medium	High
	A3: Native habitat damage by feral ungulates (browsing and trampling)	High	Medium			High	Very High		High
	A4: Decreased reproductive capacity (alien predation on native plant seeds; alien predation on water birds and seabirds, e.g. cats, mongoose)	High				High	Very High		High
	A5: Impact of problematic native species (e.g. crown-of-thorns sea star, fish disease, coral disease)			High	Medium				Medium

*The ranking of the impact of these threats come from a variety of sources: reports, expert assessments, and observations.

1.3.3 Land-based impacts

a) Effects of run-off on coral reefs

Improper coastal development and poor land management practices are some of the greatest threats to coral reefs, creating runoff of sediment and pollution that covers and kills coral. In the steep, high islands of Hawaiʻi, where the terrain slopes dramatically seaward, no place is more than 29 miles from the coast, numerous studies indicate that runoff damages coral reefs. Furthermore, sewage discharge (even when treated), and fertilizers which contain nutrients encourage the growth of algae that crowd out reef-building corals. Herbicides, soils, insecticides from homes and golf courses, oil, grease, and toxic chemicals from city streets and storm drains are all part of "land-based pollution." These effects are especially pronounced in harbors and bays, where there is less natural flushing from the tides and currents that normally move sediments off coral reefs.

b) Low levels of run-off in the Reserve

The marine waters of the Reserve are some of the most pristine in the state, attributable to good natural flushing, relative lack of land-based pollution and sedimentation, and low amounts of organic matter. The Reserve and surrounding areas are largely free of cultivation, exposed soils, or impervious surfaces such as pavement or development. Rainfall is low and the lava substrate is highly porous, and as a result, run-off is minimal most of the year. The greatest contribution of run-off comes during wet-season Kona storms which periodically carry muddy waters into the sea. Because of the excellent water quality, the state Department of Health marine water classification for this area is AA.[viii]

Figure 9. Soil run-off into Reserve waters, a threat to coral reef resources (photo by Matt Ramsey).

c) Need for preventive action

Without proactive action to care for the Reserve's resources as part of a biologic and cultural landscape, the Reserve could become hemmed in by human structures and activities and thus lose the inherent integrity that defines it as a unique Hawaiian place.

The effects of current structures in and adjacent to the Reserve are thought to be low, in terms of pollutants, night light pollution (which can disrupt wildlife), and obstruction of views, and loss of wilderness qualities. However, without proper forethought and planning, future development adjacent to the Reserve has the potential to dramatically impact Reserve resources from outside its boundaries.

Other land-based impacts to the Reserve's resources include upslope disruption of hydrology from well drilling or other changes to underground water flow. The proper functioning of anchialine pools is dependent on the natural influx of underground freshwater. On Hawaiʻi Island, the anchialine pools at Kaloko-Honokōhau National Park have been recently affected by upslope land-use changes, an impact that may be preventable at ʻĀhihi-Kīnaʻu. Fire is another land-based issue which cannot be ignored in any conservation area, especially on the dry leeward side, and planning must take this threat into account.

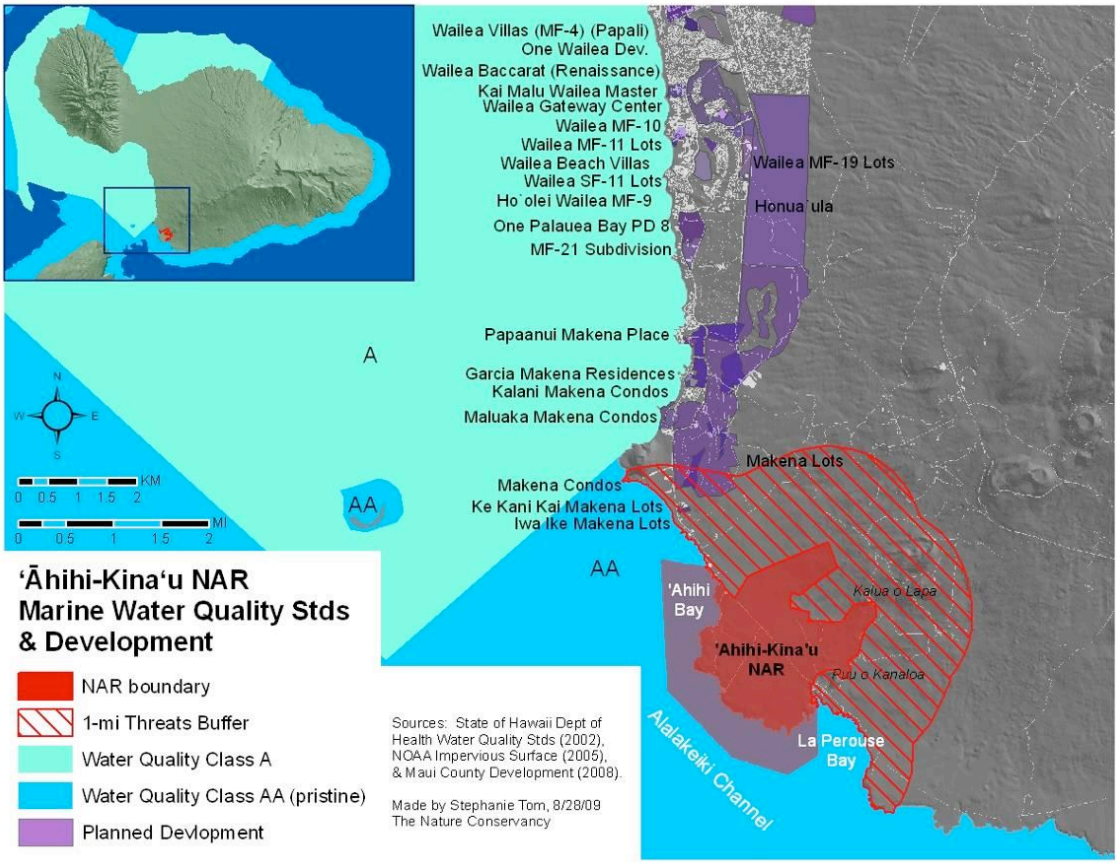

Figure 10. Map showing state water classification in the reserve and around the island of Maui, as well as current and planned development in relation to a one-mile area around the reserve (map by Stephanie Tom).

Table 7. Threats to resources from land-based sources.

⇒Targets⇒ ⇓Threats⇓		Targets							
		Anchialine pools	Cultural landscape	Coastal marine	Coral reef	Lava flows	Native shrublands	Wilderness qualities	Summary Threat Rating
Threats	L1: Proposed adjacent coastal or upslope development (e.g. land-based pollution and nutrients and resulting alien algae growth, light pollution, altered wilderness qualities and scenic resources, hydrologic regime change)	High	High	High	High			High	High
	L2: Existing coastal development (e.g. land-based pollution and nutrients, lights at night, scenic resources)	Low	Low	Low	Medium			Medium	Low
	L3: Fire						Medium		Low

1.3.4 Global impacts

a) Climate change

Climate change threatens the viability of all ecosystems on Earth. No conservation targets are immune – terrestrial, marine, freshwater, vertebrates, invertebrates, or plants. Climate change will affect each conservation target, however, to a different degree. The coarse spatial scale of current climate change data, the uncertainty inherent in projecting future greenhouse gas emissions, and the complex responses of species and ecosystems to changing climate conditions, pose challenges to addressing the threat of climate change in conservation planning. Climate change has caused vegetation shifts, phenological changes, alterations in wildlife behavior, and other significant ecological impacts (Aldous et al. 2007).

The single most important strategy for the future of coral reefs is to reduce the amount of climate change that occurs. Preventing massive damage to ecosystems on a global scale cannot be done without reducing greenhouse gas emissions and taking steps to slow down global climate change. However, even though the global scale of climate change is outside of the direct control of Reserve managers, the short- and long-term viability of biological resources are directly related to abating direct threats at a local scale.

b) Resilience to climate change

As this is a short-term plan, it is not designed to implement long-term climate change adaptation strategies. Rather, this plan provides the best available short-term approach to the long-term problem by implementing all known conservation measures needed, thereby enhancing biological integrity and therefore conferring resilience to future impacts from climate change. To achieve resilience, managers need to focus on the most pervasive current threats, which are the focus of this plan. For the Reserve's coral reefs, threat reduction includes reducing the effects of land-based sources of pollution, illegal fishing, and alien species. For native shrublands, threat reduction would include reducing the impacts of feral animals and other ubiquitous threats. Managers working to support biological community health and ecosystem function, will decrease the impacts of severe global threats.

c) Marine debris

Marine debris is another threat to Reserve resources that come from far beyond its own shores. Local action entails removal of the plastic debris once it washes up to prevent possible impacts to marine life, marine mammals, and seabirds from entanglement in nets and lines or from ingesting plastics.

Table 8. Threats to resources from global impacts.

⇒Targets⇒ ⇓Threats⇓		Targets							
		Anchialine pools	Cultural landscape	Coastal marine	Coral reef	Lava flows	Native shrublands	Wilderness qualities	Summary Threat Rating
Threats	G1: Climate change and severe weather impacts to native biodiversity (habitat shifting and alteration, e.g. coral bleaching; severe lack of rain and temperature extremes; runnoff from severe storms, ocean ph change)	High		High	High		High		High
	G2: Marine debris			Low	Low				Low

Figure 11. Staff and volunteer removing marine debris from the reserve (photo courtesy of Matt Ramsey).

1.4. What we're protecting

a) Seven priority targets for protection

Seven natural and cultural resource targets have been identified as priorities for protection within the ʻĀhihi-Kīnaʻu NAR. Native biodiversity as well as non-biological resources are included. They are: (1) anchialine pool, (2) coastal marine, (3) coral reef ecosystem, (4) cultural landscape, (5) lava flow, (6) native shrubland, and (7) wilderness qualities. Under each natural and cultural resource target are nested resources, listed specifically because of their biologic or legal status or to guide targeted management actions. It is important to note that target selection is the corner stone entire planning process, from threat identification to objective and action development. Targets are what we want to protect, conserve, or restore.

The seven target groups below consist of five ecosystem types and two targets that are present throughout the Reserve, the cultural landscape and wilderness qualities. The inclusion of these cross-cutting resources as targets allows for specific management action to be taken to preserve them. This conservation target list, together with the nested targets attempts to be inclusive of all unique native resources known to present in the Reserve.

Table 9. Conservation targets and nested resources.

	Conservation targets for the ʻĀhihi-Kīnaʻu Natural Area Reserve						
	Anchialine pool	**Coastal marine**	**Coral reef ecosystem**	**Cultural landscape**	**Lava flow**	**Native shrubland**	**Wilderness qualities**
Nested resources	Aquatic species assemblage	Sheltered bays, tidepools, Hawaiian fish ponds	Clear blue water	Traditional place names, oral histories, ecological knowledge	Lava flows and formations	Native plant assemblage	Scenic views of geologic formations
	Native herb and shrub lands	Rocky intertidal	Benthic species assemblage	Archeological, cultural, and historic sites and features	New lava aeolian community	Endangered Blackburn's Sphinx Moth	Silence and isolation
	Endangered Hawaiian Stilt nesting		Reef fish; highly mobile fish		Coastal cave community		Air quality, clear airspace
			Hawaiian Monk seal; Hawksbill and Green Turtles; Hawaiian Spinner Dolphin		Endangered seabird nesting		Dark night skies

In this section, each of the seven conservation targets and the nested resources are described. Their current status or health is rated on a scale from very good to poor (see table 10). This ranking corresponds with the natural function of the systems and the degree of human intervention required to maintain or enhance its current status. The intention of this management plan is to guide management actions to maintain or improve the health of the conservation targets, thus it is important to understand their current status. The estimated health of each is based on key ecological attributes and indicators, and a threats assessment.

Table 10. Resource health ratings.

☐ **Very good:** Functioning at its desired status. Requires little human intervention for maintenance.

☐ **Good:** Within an acceptable range of variation. May require some human intervention to maintain status

☐ **Fair:** Outside the range of acceptable variation. Requires human intervention. If unchecked, target is vulnerable to serious degradation.

☐ **Poor:** Restoration increasingly difficult. May result in expiration without effective intervention

1.4.1 Anchialine Pool

☐ **Current status is Good**

a) Overview

Anchialine pools are surface brackish water pools, fed underground from both ocean and fresh water sources, and lack a surface connection to the sea. They are found primarily in the highly porous, young coastal volcanic substrate of Hawaiʻi Island and Maui, and coastal limestone of some other Hawaiian islands. They are home to unique aquatic species and biologic communities. The vegetative and invertebrate communities surrounding the pools are also unique. There are about 600 anchialine pools in Hawaiʻi (Brock 2004). Statewide, the distinctive aquatic algal and invertebrate communities have been decimated by development, recreational uses, and introduction of alien fish species such as tilapia. The Cape Kīnaʻu pools have been spared from these threats and are considered the most biologically intact and diverse aquatic habitats in Hawaiʻi and the nation (Brock 2004). The Reserve participates in a standardized anchialine pool monitoring protocol with the National Park Service and other partners. See table 11 for a summary of the Current Status and Threat Rating for Anchialine Pools.

Figure 12. Low-stature native and non-native vegetation growing at Kauhioaiakini, the largest anchialine pool complex in the reserve (photo by Matt Ramsey).

b) Archeological record

In addition to their biological values, these brackish pools provided food resources for pre-contact Hawaiian residents who used and modified the pools for sources of bait, aquaculture, and in some cases drinking water (Desilets et al. 2007). The pools were clearly important aquaculture resources for nearby residents and remained so into the early historical period as evidenced by unique cemented cobble wall construction. The pools are well connected by traditional trails and were a focal point for temporary and permanent habitation sites (Desilets et al. 2007).

c) Physical environment

Maciolek identified 12 groupings of pools at Cape Kīnaʻu (1986), including the largest in the state, Halua (Brock 2004). Pool group size ranges from a few square meters at high tide to more than 2000 m^2 at Kauhioaiakini. Pool depths vary with the tides and some of them can be less than 0.5 m deep, but others, like in the case of Halua, can exceed 5 m in depth. The pools have variable salinities (8.0-22 %) and temperatures (22.0–28.0° C) which fluctuate with the tide through underground fissures in the porous volcanic substrate. Surface pools extend underground through volcanic cracks and fissures, areas that provide habitat for species that live all or a portion of their lives in dark, subterranean watery recesses.

d) Aquatic species assemblage

Organisms found in the Reserve pools include crustaceans, fishes, mollusks, sponges, tunicates, aquatic insects, and algae. The species of anchialine shrimp exhibit the greatest diversity and abundance (Figure 13). The diversity of these shrimp at a single site is the greatest known in the Indo-Pacific (Maciolek 1986). Of the 10 species of shrimp documented from the anchialine pools within the Reserve, five are listed as candidate species under the Endangered Species Act (Mitchell et al. 2005). Of these, three hypogeal (predominately subterranean) species are considered rare: 1) The endemic *Palaemonella burnsi (found only at Cape Kīnaʻu and vicinity), 2) Procaris Hawaiiana (found only at Cape Kīnaʻu and Lua O Palahemo, Hawaiʻi Island)*, and 3) the indigenous *Calliasmata pholidota (found on the Sinai Peninsula, Funafuti Atoll, Lua O Palahemo and Cape Kīnaʻu)* (Sam Gon pers. comm. 2008). These shrimp are critical to maintaining the characteristic orange-yellow colored cyanobacterial mat that coats the edges and shallow extents of many of the pools (Bailey-Brock and Brock 1993). This mat is maintained as the shrimp remove food from the surface of the crust. The pools also contain a diverse algal assemblage (Wong 1975).

Figure 13. Endemic anchialine pool shrimp (photo by Mike Yamamoto).

f) Terrestrial communities

Coastal herbs surround many of the pools, including native plants *ʻakulikuli* (*Sesuvium portulacastrum*), *makaloa* (*Cyperus laevigatus*), and *naio* (*Myoporum sandwicense)*. Additionally, the native *Ruppia maritima* grows within the pool itself. Native damselflies and dragonflies and other insects and arthropods occur in or near anchialine pools (Mitchell et al. 2005). The low stature of these native vegetation communities are threatened by fast growing alien species *Pluchea symphytifolia*, mangrove (*Ryizophora sp*.), *Batis maritima*, sour grass (*Digitaria insularis)*, and the indigenous *milo* (*Thespesia populnea*). If left unchecked, the spread of invasive vegetation and deposition of associated organic matter will fill in the shallow pools (Chai 1988). However, alien or other problematic vegetation (i.e. *milo*) around the pools must be removed carefully and completely to preserve the habitat of terrestrial species like the "remarkable" large black wolf spider (Howarth 1988). This native spider, *Lycosa sp*., builds a web-lined retreat in the loose ashy cindery slopes which surrounds the anchialine pools. It hunts at night and retreats into its burrow when disturbed making this invertebrate vulnerable to foot traffic.

g) Native birds

The pools provide habitat for endemic waterbirds, migratory birds, and shorebirds. The endangered *aeʻo* or Hawaiian stilt (*Himantopus mexicanus knudseni*) forage and nest in the anchialine pools. One to two successful nests per breeding season are observed at Kauhioaiakini pool (DOFAW unpublished data). Recovery of this endangered species is focused on protection of current populations and key breeding habitat. The total state population is estimated at 1,300 individuals (Mitchell et al. 2005). Shorebird populations include *hunakai* or sanderling (*Calidris alba*), *kioea* or bristle-thighed curlew (*Numenius tahitiensis*), *kolea* or lesser golden-plover (*Pluvialis dominica*), *ʻakekeke* or ruddy turnstone (*Arenaria interpres*), and *ʻulili* or wandering tattler (*Heteroscelus incanus*). The *ʻaukuʻu* or black-crowned night-heron (*Nycticorax nycticorax hoactli*) also frequent the pools. Migratory ducks and geese have also been observed. Primary threats to these birds include ants, rats, cats, dogs, mongoose, barn owls, and cattle egrets which predate on eggs, nestlings or adults.

Table 11. Current status and threats ratings for anchialine pools.

	Health Indicators Anchialine Pools	Current Status	Threat Code	Threats Anchialine Pools	Threat Rating
1A	Absence of alien aquatic species	Very Good	H2	Destruction of resources (damage to formations, structures, rock removal, spray paint, vandalism)	High
2A	Nesting success of *ae'o* or Hawaiian stilt	Good	H4	Human trampling	Very High
3A	Presence of endemic shrimp species	Good	H5	Human waste and trash	Medium
4A	Composition of plant species	Fair	H7	New trails across lava flows and damage to existing trails	Medium
5A	Composition of aquatic plant, algal and bacterial species	Fair	H8	Unexploded ordinance	Low
			A1	Potential of alien species introduction	Very High
			A2	Impact of existing introduced species (woody plant species growing around anchialine pools and archeological sites, native plant s competing with alien plants, introduced fish species)	High
			A3	Native habitat damage by feral ungulates (browsing and trampling)	High
			A4	Decreased reproductive capacity (alien predation on native plant seeds; alien predation on water birds and seabirds, e.g. cats, mongoose)	High
			L1	Proposed adjacent coastal or upslope development (e.g. land-based pollution and nutrients and resulting alien algae growth, light pollution, altered wilderness qualities and viewplanes, hydrologic regime change)	High
			L2	Existing coastal development (Pollution and nutrients, lights at night, viewplanes)	Low
			G1	Climate change and severe weather impacts to native biodiversity (habitat shifting and alteration, severe lack of rain and temperature extremes; runnoff from severe storms, ocean ph change)	High

1.4.2 Coastal Marine

☐ Current status is Good

a) Overview

Formed less than five hundred years ago by flows from the Kalua O Lapa cone, the shoreline of Cape Kīnaʻu is both intricate and rugged. The complexity and low relief of the young lava shoreline provides distinctive coastal habitat types; sheltered bays, tidepools, *loko iʻa* (Hawaiian fish ponds), and basaltic intertidal. Each of these habitat types hosts unique assemblages of species. The primary threats to these areas are human trampling, poaching, water flow and quality changes, and climate change.

b) Sheltered bays, tidepools and loko iʻa

The sheltered embayments of Cape Kīnaʻu are home to unique invertebrate and algal assemblages at different depths and exposure zones (Godwin 2004). Marine tidal pools provide yet another suite of unique sheltered habitats. Some pools are blanketed in a single species of red algae, while others are completely covered in zoanthids. Nearby pools can have fragile corals growing within inches of the water's surface, or rocks covered in coralline algae from red to deep purple hues. Deep inlets on the shore were modified into distinctive *loko iʻa* or fishponds by native Hawaiians many years ago. Today, the calm waters still host the fish favored for cultivation such as *ʻamaʻama* (*Mugil cephalus*) and *ʻōʻio* (*Albula virgata*). Some the brackish ponds provide habitat for the rare *Ruppia maritima,* a flowering plant which grows completely underwater. While some sheltered coves have less coral cover and more coralline algae, others contain high levels of easily breakable corals and thus vulnerable to trampling. An index of coral trampling sensitivity was developed by the Hawaiʻi Institute of Marine Biology (HIMB), based on the depth of the water, species skeletal strength, species morphology, rare coral species and percent coral cover (Rodgers and Jokiel 2008). Of the 18 sites evaluated in the Reserve, the ones most vulnerable to trampling are on the southeastern shore of Cape Kīnaʻu in the sheltered habitats described above.

Figure 14. Ancient Hawaiian modified tide pool built for raising fish (photo by Matt Ramsey).

c) Basalt intertidal

The complexity of the lava rock shoreline provides protection for herbivorous and schooling fishes (Hodgson and Abbott 1992). In turn, the low levels of anthropogenic nutrient inputs (farming, sewage treatment plants, etc.) and high levels of herbivorous (algae eating) fish and invertebrates like urchins keep algae growth down. While the alien algae Hypnea musciformis has been noted in the Reserve (Eric Conklin pers. comm.), the relative lack of alien algae in the intertidal and shallow water marine areas may be attributable to high levels of herbivory and "natural" nutrient input levels via underground freshwater flow. This type of shallow water habitat, vital fish nursery areas and refugia, have been degraded or eliminated from other Maui shorelines due to the overgrowth of alien algae.

The intertidal areas of the Reserve are notable for their diversity of native algae. One hundred and twenty four species were identified in the intertidal and shallow subtidal collections from the basaltic shoreline of Cape Kīnaʻu, including new Hawaiian records for two genera and fifteen species (Hodgson and Abbott 1992). The Reserve intertidal zone is also notable for healthy populations of intertidal invertebrates such as *ʻopihi* (*Cellana* spp.), *haʻukiʻuki* (*Colobocentrotus atratus*), and *aʻama* (*Grapsus tenuicrustatus*) (NPS 2003). The

Reserve is a site of a standardized *ʻopihi* and intertidal monitoring survey.

Table 12. Current status and threat ratings for coastal marine.

	Health Indicators Coastal Marine	Current Status	Threat Code	Threats Coastal Marine	Threat Rating
1C	Montipora sp. coral in sheltered tidepool	Good	H3	Illegal harvest of marine species	High
2C	Rocky intertidal species assemblage	Good	H4	Human trampling	Medium
3C	Species composition/relative abundance in sheltered bays	Good	H8	Unexploded ordinance	Low
4C	Invasive and/or alien species composition/relative abundance	Good	A1	Potential of alien species introduction	Medium
			A2	Impact of existing introduced species(woody plant species growing around anchialine pools and archeological sites, native plant s competing with alien plants, introduced fish species, e.g. roi, ta'ape)	Medium
			A5	Impact of problematic native species (e.g. crown-of-thorns sea star, fish disease, coral disease)	High
			L1	Proposed adjacent coastal or upslope development (e.g. land-based pollution and nutrients and resulting alien algae growth, light pollution, altered wilderness qualities and viewplanes, hydrologic regime change)	High
			L2	Existing coastal development (Pollution and nutrients, lights at night, viewplanes)	Low
			G1	Climate change and severe weather impacts to native biodiversity (habitat shifting and alteration, e.g. coral bleaching; severe lack of rain and temperature extremes; runnoff from severe storms, ocean ph change)	High
			G2	Marine debris	Low

1.4.3 Coral Reef Ecosystem

☐ Current status is Good

a) Overview

The Reserve encompasses marine waters from shore to approximately a half mile from a middle point in ʻĀhihi Bay, around Cape Kīnaʻu, which ends just seaward of the shoreline and fishpond at Keoneʻōʻio. Water depths range from 0-35 m (0-115 feet). Legally protected from extractive activities for more than 30 years, and largely free of sediment, pollution and nutrients from human activities, the coral reef ecosystems of the Reserve are among the finest in the main Hawaiian Islands.

The current threats to reefs within the Reserve include, lack of visitor awareness of proper conduct when snorkeling, human trampling of corals, motorized vessel traffic, anchoring, interaction with protected species (sea turtles and dolphins), poaching of fish and invertebrates, alien fish species, crown-of-thorns sea stars and coral disease, and land-based pollution. Impending or potential threats include proposed adjacent or up-slope land use changes and resulting pollution into the ocean, unregulated human uses, climate change and ocean acidification, and the degradation of surrounding marine areas. Connectivity among reefs often dictates that the replenishment of coral communities and fish stocks depends on nearby healthy

reefs, therefore care of surrounding reefs is also an essential component to maintaining the viability of Reserve reefs. See table 13 for a ranked list of threats to the Reserve's coral reefs.

Figure 15. Underwater view of the Reserve's coral reef (photo by Jim Petruzzi).

Two sites within the Reserve, Kanahena Bay and Kanahena Point, have been part of a long-term monitoring study of nine Maui reefs by the Coral Reef Assessment and Monitoring Program (CRAMP), a HIMB program conducted in partnership with the Division of Aquatic Resources (DAR). Over an eight-year period, these two sites exhibited opposite trends. Kanahena Bay was the only Maui reef to increase coral cover (17-30% 1999-2006) (DAR and CRAMP 2007). In contrast, coral cover at Kanahena Point declined from 23-26% over the same time period. The decline at Kanahena Point was attributed to the coral-eating crown-of-thorns sea stars (*Acanthaster planci*) (Rodgers et al. 2009). Periodic sea stars population explosions have been documented in some areas of Hawaiʻi, however, they have not caused damage extensive enough to warrant a management response. This species occurs in tropical coral reefs in the Indo-Pacific where they have caused extensive reef damage in some locations.

b) Water quality

The marine waters in the Reserve are classified as class AA (Figure 10) under Hawaiʻi State Administrative rules. Currently the only long-term water quality monitoring (State Department of Health) occurs at Oneloa Beach a half mile north (Watson Okuba pers. comm. 2009). Marine sediment samples collected in the Reserve compared to other Maui sites show lower levels of terrigenous materials, higher percentage of carbonates, and similar levels of organic materials. The high carbonate composition results from extensive coral development, high calcareous algal cover, and the high rate of bio-erosion by urchins and other herbivores (Rodgers et al. 2009). In another effort to quantify nutrient levels and sources by Meghan Dailer, the Kanahena Point CRAMP site had the highest nutrient levels of all Maui sites checked (Russell Sparks pers comm.). The Reserve has heavy underground freshwater inputs and those freshwater sources are likely high in nitrogen from natural sources like dry land forest.

c) Benthic species assemblage and invertebrates

The shallow water coral reefs of the Reserve are characterized by low rugosity volcanic rock and boulder habitats, and patches of encrusting and lobate corals. Deeper reefs are structurally complex, characterized by aggregated coral heads and sand patches. At least 33 species of coral are found at depths from <1 to 30 m. This diverse coral assemblage has a high percentage of unusual species including the rare *Pavona maldivensis* (Rodgers et al. 2009). Crustose coralline algae is more abundant here than in survey areas outside the Reserve. The slate pencil sea urchin (*Heterocentrotus mammillatus*), and the rock boring urchin (*Echinometra mathaei*) are the most abundant among the macro invertebrates, with densities recorded at 1-15 per m2 at many locations (Rodgers et al. 2009). The make-up of the marine environment suggests that it evolved around naturally high nutrient levels. High primary productivity produces copious amounts of coralline algae and supports urchin populations that are very high when compared to other areas around Maui.

At least 52 other subtidal invertebrate species (not including corals) were recorded in three survey sites within the Reserve in 2004, of which numerous rare individuals were represented (Godwin 2004). Lava tube caves host numerous invertebrates including a red acorn worm, found only in the Reserve's underwater lava-tube caves (<-25 m), and not yet described by scientists. These unique red worms belong to the phylum *Hemichordate* and the class *Enteropneusta* (Fielding 1994).

d) Reef and highly mobile fish

Visual fish surveys were conducted in the Reserve in 1972, 1985, 2000 and 2007. The most common species documented in both abundance and biomass is *kole*, the goldring surgeonfish (*Ctenochaetus strigosus*). In surveys conducted by HIMB in 2007, herbivores accounted for almost 75% of the total biomass; significantly higher than the statewide herbivore averages (59 %) of the 55 CRAMP survey sites (Rodgers et al. 2009). Invertebrate feeders make up 10%, zooplankton feeders 7%, and fish that eat other fish 8% of the total fish biomass. Overall, 75 species of fish (17 endemic) from 21 families were recorded. Two introduced fish were recorded, the snapper *taʻape* (*Lutjanus kasmira*), the grouper *roi* (*Cephalopholis argus*), and the black-tailed snapper *toau* (*Lutjanus fulvus*).

e) Effects of refugia

Marine protected areas like the Reserve provide refuge for larger fish which produce more and better eggs than smaller fish, protect habitats and biodiversity, and provide a spill-over of eggs and adults to adjacent areas. HIMB research indicates overall fish biomass is greater in the Reserve than in adjacent areas surveyed (Rogers et al. 2009), as well as other open areas in Maui (Rogers 2005). Some fish species commonly exploited for commercial and recreational uses are common in the Reserve (Rodgers et al. 2009), and fishers often dive just outside of the Reserve to take advantage of the enhanced fishing adjacent to the Reserve (Matt Ramsey pers. comm. 2008).

f) Protected species

Five marine species with protected status frequent the Reserve: *ʻilio-holo-i-ka-uaua* or Hawaiian monk seal (*Monachus schauinslandi*), *ʻea* or the hawksbill turtle (*Eretmochelys imbricata*), *honu* or the green sea turtle (*Chelonia mydas*), *naiʻa* or spinner dolphin (*Stenella longirostris*), and *koholā* or humpback whale (*Megaptera novaeangliae*).

The Hawaiian monk seal is listed as an endangered species under the federal Endangered Species Act (ESA) since 1976 and also under State law. Current populations are estimated at 1,100-1,200 archipelago wide and declining, as only one of five juvenile monk seals reaches maturity. Monk seals have been sighted in the Reserve annually since NOAA data collection began in 2002 (Wurth 2008).

Two sea turtle species occur in the Reserve. The hawksbill turtle is rarely sighted, but nests at nearby Oneloa Beach in Mākena State Park (King et al. 2004). Only 72 females, listed as endangered under the ESA and State law, nest in the main Hawaiian Islands (Mitchell et al. 2005). The green sea turtle is listed as threatened under the ESA and State law. In Hawaiʻi, the green sea turtle is genetically distinct from worldwide populations. In the first 25 years of legal protection (in 1978), populations increased 53%, but still face numerous threats today. Green sea turtles are frequently observed in the Reserve.

The spinner dolphin population is estimated at 3,300 individuals in Hawaiian waters. Protected by the Marine Mammal Protection Act, the species is not considered depleted in Hawaiʻi, however rule-making around provisions of the act are being considered in an environmental impact study by NOAA Fisheries Service to reduce human-dolphin interactions during daytime resting. Spinner dolphins rest during the day in La Pérouse Bay near the Reserve boundary where they are visited by tour boats and swimmers on a regular basis (HWF 2008). Consequently, La Pérouse Bay remains listed as a potential time-area closure site to protect the spinner's resting habitat (Jayne LeFors pers. comm. 2009).

The *koholā* or humpback whale is an endangered species. In 1993 it was estimated that there were 6,000 whales in the North Pacific Ocean, and that 4,000 of those came to Hawaiʻi. Subsequently, the population is estimated to be growing at between 4% and 7% per year. Today, as many as 10,000 humpback whales may travel to Hawaiʻi each year from their North Pacific feeding grounds to mate, calve, and nurse their young. Because these massive mammals frequent Reserve waters during the winter months, reserve waters are also included in the Hawaiian Islands Humpback Whale National Marine Sanctuary.

Table 13. Current status and threat ratings for coral reef ecosystem.

	Health Indicators Coral Reef Ecosystem	Current Status	Threat Code	Threats Coral Reef Ecosystem	Threat Rating
1R	Benthic community structure	Good	H3	Illegal harvest of marine species	High
2R	Mobile species composition/relative abundance	Good	H4	Human trampling	Medium
3R	Availability of haul out, resting, or foraging areas for monk seals and sea turtles	Good	H6	Motorized ocean vessels in the reserve; anchoring	Medium
4R	Invasive and/or alien species composition/relative abundance	Good	H8	Unexploded ordinance	Low
5R	Clear, blue water	Good	H9	Protected species harassment	Medium
			A1	Potential of alien species introduction	Medium
			A2	Impact of existing introduced species(woody plant species growing around anchialine pools and archeological sites, native plant s competing with alien plants, introduced fish species, e.g. *roi*, ta'ape)	Medium
			A5	Impact of problematic native species (e.g. crown-of-thorns sea star, fish disease, coral disease)	Medium
			L1	Proposed adjacent coastal or upslope development (e.g. land-based pollution and nutrients and resulting alien algae growth, light pollution, altered wilderness qualities and viewplanes, hydrologic regime change)	High
			L2	Existing coastal development (Pollution and nutrients, lights at night, viewplanes)	Medium
			G1	Climate change and severe weather impacts to native biodiversity (habitat shifting and alteration, e.g. coral bleaching; severe lack of rain and temperature extremes; runnoff from severe storms, ocean ph change)	High
			G2	Marine debris	Low

1.4.4 Cultural Landscape

☐ **Current status is Good**

a) Overview

The rich cultural landscape of the Reserve includes Native Hawaiian village sites, *heiau*, *ahu*, burials, trails, shelters, caves, fish pond complexes, traditional place names, oral histories, ecological knowledge and mythology of the travels of the Hawaiian deity preserved in the landscape. Furthermore, post-contact structures such as ranching walls and a lighthouse site reveal life in this region for many in early Hawaiʻi. The cultural landscape is the entirety of the landscape, the physical history, and living connections to the place and past. As defined by the World Heritage Centre, cultural landscapes are distinct geographical areas or properties that uniquely represent the combined work of nature and man (UNESCO 2008).

Cultural sites within the Reserve have been damaged by tree growth, trampling by hoofed animals, as well as by human trampling, impacted by human waste and trash, and by direct vandalism such as spray painting. Another threat to cultural resources is the lack of preservation

and sharing of native Hawaiian and regional culture and history, which makes it vulnerable to loss. In spite of the impacts described in some locations, many of the cultural sites here remained largely intact and thus constitute an outstanding opportunity for preservation and interpretation of these irreplaceable resources.

Figure 16. A lava structure adjacent to an anchialine pool, part of the rich cultural landscape of the reserve (photo by Matt Ramsey).

b) Traditional place names, oral histories and ecological knowledge

The Sea of Keoneʻōʻio (La Pérouse Bay) and the Reserve are the setting for many historic and supernatural events. Of Pele's adventures in the area, the story is told of how the goddess coveted the handsome Paea, who fled with his sweetheart, Kalua, toward the bay of Keoneʻōʻio where he kept his canoe and fishing gear. Pele caught up with the mortals near Puʻu Māhoe, where she turned Paea's body into Pōhaku Paea, in the sea near Mokuha. She caught Kalua at Puʻu Naio (Hill of Conquest) and turned her into the ridge just below the hill, called Puʻu Kalua-lapa (Sterling 1998). Today, this site is known as, Kalua O Lapa, the volcanic vent that created Cape Kīnaʻu.

Renowned for its rich fishing grounds, fish ponds and shark lore, historic accounts and descendants of the area offer rich insights into the marine environment. As an example, the fishponds of Keoneʻōʻio were credited to high chief Kauholanuimahu (of Hawaiʻi Island), whose *ʻaumakua*, a benign shark entered the pools via an underground passage bringing with him schools of fish (Sterling 1998). Kamakau, the preeminent native Hawaiian scholar wrote in the mid-1800s that he met a woman who lived at Maʻonakala in Kanahena who was engulfed by a shark there, but her life was spared through the efforts of a small shark that freed her (Sterling 1998). According to oral histories from native residents from Mākena to Keoneʻōʻio, unique relationships with certain sharks were commonplace (Maly and Maly 2005). Overall, records indicate that in the past larger and higher densities of marine life existed here, as did unique relationships and strong connections between native residents and the land and sea of Honuaʻula (ibid).

Place names record many stories of this land and are integrally connected to places across the landscape. An interview with a descendant of Honuaʻula, Leslie Kuloloio, emphasizes the role of fishermen in the naming of each coastal feature to help locate fishing grounds (Desilets et al. 2007). Another important component of the protection and preservation of the cultural landscape is the direct involvement of lineal descendants in the Reserve's management and activities. Currently there are two arenas of this involvement, 1) through representation on the

ʻĀhihi-Kīnaʻu NAR/Keoneʻōʻio Advisory Group (Advisory Group), and 2) through a NAR permit process. Past permits have been granted to perpetuate traditional practices in the Reserve, a *kuleana* maintained by the Luʻuwai *ʻOhana*.

c) Archeological, cultural, and historic sites and features

The Reserve contains a variety of traditional Hawaiian and early historic resource sites. Cultural and historic sites are protected within the boundaries of the Reserve by HAR 13-209-4, which prohibits removal, damage and disturbance of any historic or prehistoric remains. Some Reserve sites at Keoneʻōʻio are included in the La Pérouse Archeological District which is on the Hawaiʻi Register of Historic Places.

The Cultural Resource Management Plan for the ʻĀhihi-Kīnaʻu NAR and Keoneʻōʻio was completed in March 2007 (Desilets et al. 2007). It focuses on the management of cultural resources along the most frequented traffic corridors. Additionally, the cultural survey team conducted an ethnographic and underwater survey. The plan identifies the current status of sites, their vulnerability to damage, their priorities and offers opportunities for better management of these sites. The southeastern portion of the Reserve contains the highest density of archeological features. The area includes trail networks, rock shelters, habitation complexes, modified anchialine and marine pools, and *heiau*, clearly illustrating the importance of this area and the significant fishing grounds for this region of the island. Additionally, the Reserve also contains modern sites such as the remains of the Kanahena light house used from 1886-1918, which was later replaced by the navigational beacon at Cape Hanamanioa.

The Reserve contains a variety of traditional Hawaiian and early historical cultural resource sites. Some, such as Maonakala Village Complex in Kanahena are well known. In 1971 a team from the Bernice Pauahi Bishop Museum cleared and mapped the ruins at Maʻonakala (Desilets et al. 2007). The Bishop Museum team identified nine major archeological features including a canoe shed, a *heiau*, a well, and several *ʻiliʻili* paved house enclosures. In 1974, the complex was listed in the Hawaiʻi Register of Historic Places as Site 50-50-14-1018(Desilets et al. 2007). However, as of 2010the site is no longer listed, according to the Hawaii State Historic Preservation Division. Other known archeological resources in the Reserve include a series of sites and complexes identified by R. Bordner during his Chaminade University field school survey (Bordner 1990). He inventoried the Kualapa cluster, Kauhioaiakini and Halua pools, as well as sites along the trails leading to these features.

Adjacent to the Maʻonakala Village Complex in the parking area fronting the surf break known as “dumps,” was a World War II era dumpsite, cleaned up sometime between the late 1960s and 1973. One eyewitness described the dumpsite at Kanahena (as “an open junkyard ...cast off washing machines and stoves, barbed wire, glass, crushed and rusting oil drums and tin cans...provide an element of sheer destruction that is without peer” (Warnecke n.d.). Robert Luʻuwai shares that during WWII, Maui’s coastline was encased in barb wire waiting for the second attack by Japan. After the war, the Army Corp of Engineers removed the wire from the Mākena area and dumped it at the location of what is currently the Reserve’s Kanahena Parking Area. As a result of this initial dumping, people began dumping stuff there that could not burn (old washing machines, etc.) (Luʻuwai pers. comm. 2009). In 1973, Inez Ashdown expressed relief that the clean up (of the dumpsite) was finally complete. She wrote, "thanks to Harry Gibson and those with whom he works, we have eradicated the horrid wartime dump-site there

in the historic village called Maona-ka-la."

Table 14. Current status and threat ratings for the cultural landscape.

	Health Indicators Cultural Landscape	Current Status	Threat Code	Threats Cultural Landscape	Threat Rating
1L	Cultural and historic sites intact	Good	H1	Vehicular traffic (noise, emissions, congestion, wear and tear, off-road vehicles)	High
2L	Traditional place names, knowledge of place, practices, histories	Fair	H2	Destruction of resources (damage to formations, structures, rock removal, spray paint, vandalism)	High
3L	Documentation of archeological, cultural, and historic sites and features	Fair	H4	Human trampling	High
			H5	Human waste and trash	Medium
			H7	New trails across lava flows and damage to existing trails	Medium
			H8	Unexploded ordinance	Low
			A1	Potential of alien species introduction	Low
			A2	Impact of existing introduced species(woody plant species growing around anchialine pools and archeological sites, native plant s competing with alien plants, introduced fish species, e.g. roi, ta'ape)	High
			A3	Native habitat damage by feral ungulates (browsing and trampling)	Medium
			L1	Proposed adjacent coastal or upslope development (e.g. land-based pollution and nutrients and resulting alien algae growth, light pollution, altered wilderness qualities and viewplanes, hydrologic regime change)	High
			L2	Existing coastal development (Pollution and nutrients, lights at night, viewplanes)	Low

1.4.5 Lava Flow

☐ Current status is Good

a) Geologic setting and age of lava flows in ʻĀhihi–Kīnaʻu Natural Area Reserve

The ʻĀhihi–Kīnaʻu Natural Area Reserve encompasses young rugged lava flows on Haleakalā volcano's southwest rift zone. The Reserve includes the Kalua O Lapa cinder cone and *ʻaʻā* lava fed by it (Sherrod et al. 2007). These lava flows reach seaward, forming Cape Kīnaʻu and coating the adjacent offshore sea floor. Thus the Reserve is the only protected area in Hawaiʻi to enclose an entire lava flow from its source to end point on the ocean floor (Figure 18).

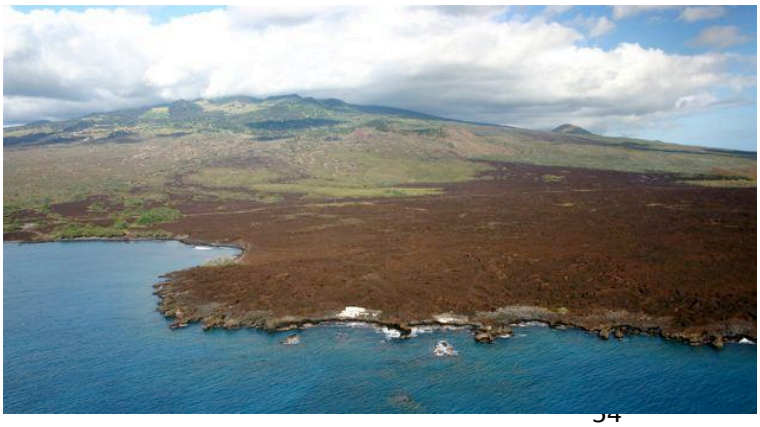

Figure 17. The ʻAhihi-Kīnaʻu Natural Area Reserve encompasses young rugged flows from Haleakalā volcano's southwest rift zone (photo by Judy Edward).

Also within the Reserve is the coastal part of an older, similar sequence of lava flows that lies to the northwest of the Kalua O Lapa lava. This older sequence, the Kanahena flows, erupted from an unnamed fissure at about the 430 m altitude (1,400 feet) on the southwest rift zone. It is named for the *ahupuaʻa* and a small coastal settlement where the flows meet the shoreline.

Kalua O Lapa, the best known of these two lava sequences, began its eruption along a short narrow fissure now marked by spatter ramparts. The eruption must have formed quickly at the site of the Kalua O Lapa, where most of the cinders and spatter were erupted to build a cinder cone 50 m (160 feet) high. Lava erupting from this site oozed downslope to form the stark blocky lava terrain traversed today by the Mākena Road as it passes to La Pérouse Bay. At least one of the flows crusted over, so that molten lava moving beneath it could ultimately drain out creating a natural tunnel or lava tube. Collapsed sections of the roof along this tube created natural cave openings accessed and used by early settlers.

The rough surface of the Kalua O Lapa lava creates a hummocky terrain whose deepest depressions are near the shoreline. Several depressions along the coastal stretch have floors that lie below sea level, allowing ocean water to infiltrate and form shallow anchialine pools. The Kanahena lava sequence is also *ʻaʻā* but somewhat lower in relief than the Kalua O Lapa lava. It too lacks vegetation indicative of its young age compared to other flows. There are no lava tubes associated with the Kanahena sequence. The Natural Area Reserve encloses only the lower, downslope half of the Kanahena sequence. See section 1.1.1 for more on the age of the flows.

b) Ecosystems and habitat created by young lava flows in the Reserve

The unique geologic characteristics of the young flows created at least four unique ecosystems: 1) Aeolian (wind-supported) ecosystems on unvegetated lava; 2) Lava tube cave and associated subterranean voids; 3) Littoral (associated with the marine coast) habitats; and 4) Seabird nesting habitat. Native shrublands and anchialine pools are discussed separately. In addition, the distinctive geography of the flows provides navigational markers for seasonal feeding by *ʻōpeʻapeʻa*, the Hawaiian hoary bat (*Lasiurus cinereus semotus*) at dusk along the shoreline (Thane Pratt pers. comm. 2008). The Reserve is also a flyway for *ʻuaʻu*, the Hawaiian petrel (*Pterodroma sandwichensis*), returning to their nesting areas at night at the top of Haleakalā (Fern Duvall pers. comm. 2008). Both these species are listed as endangered under the ESA. The primary threats to the geologic formations and lava-associated ecosystems are impacts of direct vandalism to lava flow structures and resources, human presence, foot traffic and noise in sensitive areas, lights at night that could disrupt wildlife behavior, and alien species that consume, harm, or compete with native species.

c) Aeolian (wind-supported) ecosystems on unvegetated lava

On the barren new lava of the Reserve, a community of insects and spiders lives hidden in the *ʻaʻā* clinker, cracks and recesses, feeding on windborne debris. These unique communities are called neo-geo-aeolian, or new lava aeolian. Within six months of an eruption, months before the first plant life, native invertebrates begin to colonize a lava flow, representing the early stages of formative aeolian ecosystems (Howarth 1979). Lichens and ferns follow, which are succeeded over time by other plant communities. Native insect and arthropod species

documented during Howarth's (1988) survey include the case-building larvae of the native *Hyposmocoma* moth and orb-weaving *Cyclosa* spider (Hawaiʻi Heritage Program 1989). The endemic dragonfly, *Anax strenuus* is commonly seen searching for the aeolian insects. Walking on or disturbing the *ʻaʻā* clinker surface changes the character of the surface, disturbing lichen growth and aeolian species habitats, and encourages the dispersal of weed propagules contributing to higher plant establishment (Ibid).

d) Lava tube cave and associated subterranean voids

Terrestrial cave-adapted insects and arthropods live primarily in medium size voids. They can live only where the air is stagnant, saturated with water vapor, and where food is present (from surface vegetation via roots). Cave faunas are mostly associated with younger lava flows, before erosion fills the medium sized voids (age range is from a few 100 to a few 1,000 years old). Of the cave-adapted species found at Kalua O Lapa, the isopod, *Hawaiʻioscia parvituberculata*, is endemic to this cave complex. The sheetweb spider, *Meioneta gagnei* shares the same unique characteristics with the isopod. Both have evolved to become sightless. Both have been found in the few caves known at Kalua O Lapa, , however, the subterranean extent of the cave system is not documented, and therefore, the distribution of these species within the Reserve is not known. Furthermore, Kalua O Lapa cave also contains important native Hawaiian cultural and archeological remains including a number of human burials. Because of extensive vandalism to these remains and cultural record, the cave entrances have been permanently sealed to preserve their sanctity and integrity.

e) Littoral (associated with the marine coast) habitat

The Reserve contains one of the finest undisturbed boulder beaches on Maui. While the unique marine mollusks and crustacea have been described, the numerous insects and myriapods, many of which are strictly nocturnal, have not. One of the more remarkable animals is the endemic marine cricket, *Caconemobius sp*., which is found by the hundreds along the margins of Reserve boulder beaches and anchialine pools. This cricket and other habitat associated species live on the coast and up to several hundred feet inland, where there are few other competing species (Howarth 1988).

f) Seabird nesting habitat

Recent surveys for nesting seabirds in the reserve have found none. However, the burrows and protective crevices of the new lava provide suitable nesting habitat for two small seabirds, *ʻakēʻakē*, or band-rumped storm petrel (*Oceanodroma castro*), and *ʻou* or Bulwer's petrel (*Bulweria bulwerii*). Both have declined from coastal areas of the main islands statewide due to human impacts, and both are expected to have been common in the reserve prior to human disturbance. Remains of two *ʻakēʻakē* were found on Cape Kīnaʻu on two separate occasions in 1987 and 1988, indicating to biologists that the birds may continue to attempt to nest there (DOFAW unpublished data 2008). The rugged terrain and deep lava tubes and fissures of the new lava may provide some protection from disturbance by people, predators (e.g., cats, rats, dogs, and ants), and harsh weather, suggesting that threat management would result in successful recovery for those species. Surveys to determine presence and location of nesting seabirds are needed to guide specific management strategies for the Reserve.

The *ʻakēʻakē*, a state-listed endangered seabird, is the smallest and rarest seabird that nests in Hawaiʻi (Mitchell et al. 2005). The *ʻou* or Bulwer's petrel is a highly pelagic, nocturnal gadfly petrel with a pantropical distribution. It is recognized by the state as indigenous. The largest nesting colony in the world is on Nihoa Island.

Table 15. Current Status and Threat Ratings for Lava Flow

	Health Indicators Lava Flow	Current Status	Threat Code	Threats Lava Flow	Threat Rating
1F	Natural lava formations unmodified; Lava flows and formations - condition	Good	H1	Vehicular traffic (noise, emissions, congestion, wear and tear, off-road vehicles)	Medium
2F	Habitats unmodified (littoral, cave, Aeolian)	Good	H2	Destruction of resources (damage to formations, structures, rock removal, spray paint, vandalism)	High
3F	Use of habitat by Hawaiian Hoary Bat, Hawaiian Petrel,	Good	H4	Human trampling	Medium
4F			H7	New trails across lava flows and damage to existing trails	Medium
5F	Use of habitat by Band-rumped Storm Petrel	Poor	H8	Unexploded ordinance	High
			A1	Potential of alien species introduction	Low
			A2	Impact of existing introduced species(woody plant species growing around anchialine pools and archeological sites, native plant s competing with alien plants, introduced fish species, e.g. roi, ta'ape)	Medium
			A3	Native habitat damage by feral ungulates (browsing and trampling)	High
			A4	Decreased reproductive capacity (alien predation on native plant seeds; alien predation on water birds and seabirds, e.g. cats, mongoose)	High
			G1	Climate change and severe weather impacts to native biodiversity (habitat shifting and alteration, e.g. coral bleaching; severe lack of rain and temperature extremes; runnoff from severe storms, ocean ph change)	High

1.4.6 Native Shrubland

☐ Current status is Poor

a) Overview

The Reserve is part of the lowland dry ecotype (The Nature Conservancy 2009). A mix of native and non-native vegetation covers approximately 17 percent of the terrestrial portion of the Reserve. Of this vegetated area, approximately 18 percent is native and 82 percent is non-native. These areas are largely *mauka* of the road except at Keoneʻōʻio and Kanahena . Rainfall is low, ranging from 400 mm (15 inches) along the coastline to 600 mm (24 inches) per year along the *mauka* boundary 152 m (500 feet) elevation (Rodgers et al. 2008). When compared to the historical extent of this ecotype for the island of Maui, less than 2% of the native vegetation is left today. The life cycles of plants in elevations below 304 m (1,000 feet) elevation, are keyed to a very severe and prolonged dry season and variable wet season (Medeiros, Loope and Holt 1986).

The primary threats to native vegetation are browsing and grazing by feral ungulates, vegetative damage by alien insects, and drought conditions. Other threats include direct competition with introduced plants, seed predation by rats and mice, fire, and climate change. However, it has been shown that in the absence of major threats such as ungulates and introduced grasses, areas of the lowland dry ecotype have an advantage in lava and thin soil substrate and recover well following threat reduction actions. Examples of this type of recovery projects are at Puʻu O Kali, Papapakai, Auwahi, and Kanaio, where ungulate movement has been controlled through fencing. The following is a description of the plant communities compiled from the Hawaiʻi Heritage Program (1988) and surveys completed by Warshauer, Jacobi, and Price (2008). These studies identified plant communities, both non-native and native dominated, that are associated with pioneer vegetation on lava flows.

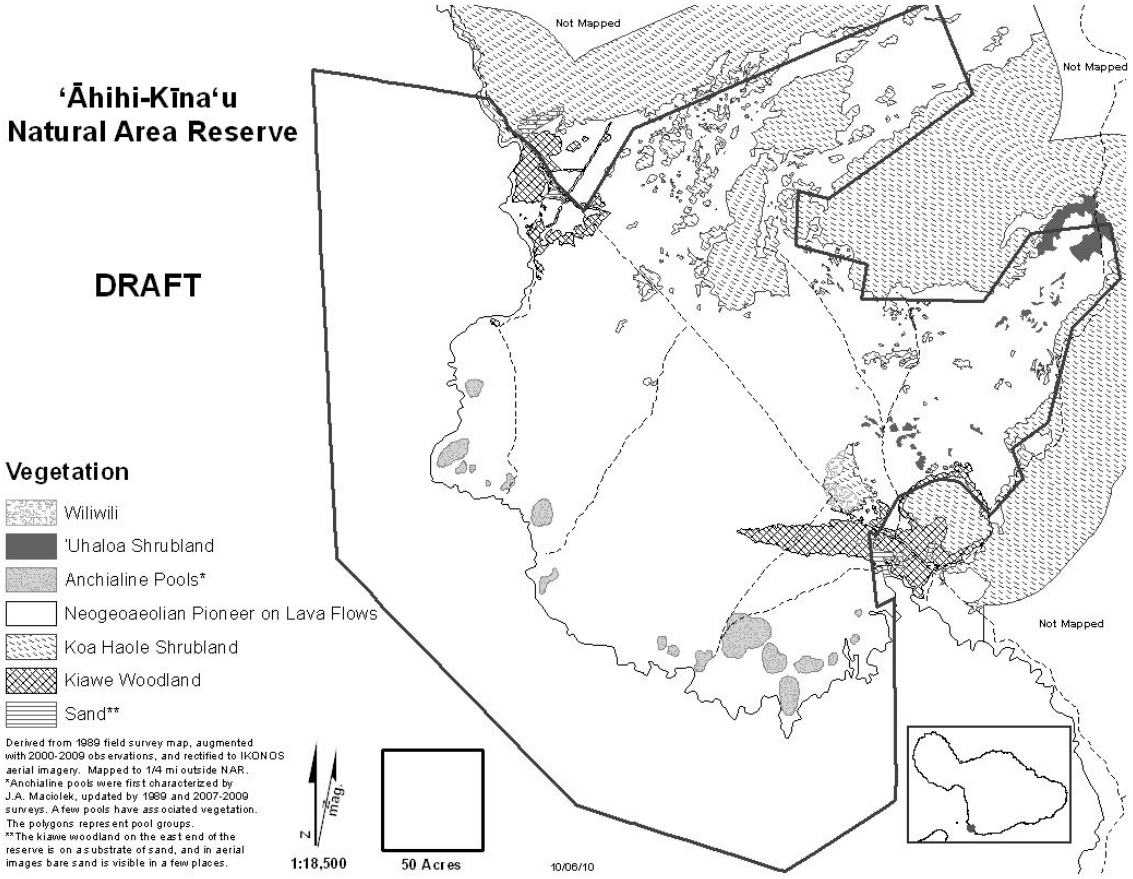

Figure 18. Reserve map showing vegetation, community, and substrate types (map by Stephanie Tom).

b) Non-native dominated

In the shallow soils and rugged lichen covered *aʻā* of a *kīpuka* located *mauka* of the road near Puʻu O Kanaloa, native *wiliwili* trees (*Erythrina sandwicensis)* grow within large groves of non-native *kiawe* or mesquite (*Prosopis pallida*) trees. The summer deciduous endemic *wiliwili* is an important tree of the remnant native dry forest zone, now severely threatened by the *Erythrina* gall wasp, a recently-introduced insect which consumes the leaves of the tree. In the *kīpuka* below the road, tree growth is largely *kiawe*, where lava is overlain with sand. The sub-

canopy vegetation is composed of the native shrubs *ʻilima* (*Sida fallax*), *ʻuhaloa* (*Waltheria indica*), *naio* (*Myoporum sandwicense*), *ilieʻe* (*Plumbago zeylanica*), and non-natives *koa haole* (*Leucaena leucocephala*), and Spanish needle (*Bidens pilosa*). In older lava *kipuka*, *koa haole* dominates the native *ʻilima* shrubland. Rare species include *maiapilo* (*Capparis sandwichiana*) and *ʻāwikiwiki* (*Canavalia pubescens*).

c) Native assemblages on pioneer vegetation on lava flows

ʻUhaloa is found in small *kipuka*, especially where lava flows are in transition between *pahoehoe* (smooth lava) and *aʻā*, in some cases up to 50 percent cover. Additional native species found here include *pili* grass (*Heteropogon conortus*), and *maiapilo*. *Maiapilo* is abundant on the *aʻā* flows relative to the few other areas of Hawaiʻi where it is found. In some areas, Parmelioid lichens, early colonizers, are found on the rough lava surfaces. Non-native species compose the rest of the community. These include *koa haole*, *kou* (*Acacia farnesiana*), and natal redtop (*Rhynchelytrum repens*).

The endemic shrub *maiapilo* (*Capparis sandwichiana*), a member of the caper family, is one of the most common native shrubs found in the reserve. *Maiapilo* perseveres where many other natives do not as it is almost completely non-edible by ungulates (Art Medeiros pers. comm. 2008). Persisting in the harshest and driest environments in Hawaiʻi, interestingly *maiapilo* remains green year-round. Among the sweetest smelling flowers of Hawaiian flora, *maiapilo* can sometimes be smelled before it can be seen. A rare native moth is found exclusively on this plant, which produces a copious amount of nectar, likely an important food source for adults of another large native moth. Blossoms open in the evening and stay open throughout the night, only to close during daylight hours. Some have speculated the plant is named for its banana shaped fruits which are foul smelling when ripe.

Table 16. A summary of the most common native and introduced plant species found in the Reserve.

Native plant species	Non-native species
akulikuli (*Sesuvium portulacastrum*)	pickle weed (*Batis maritima*)
awikiwiki (*Canavalia pubescens*) (C)	mesquite (*Prosopis pallida*)
alena (*Boerhavia herbstii/Boerhavia repens*)	klu (*Acacia farnesiana*)
hao (*Rauvolfia sandwicensis*)	koa haole (*Leucaena leucocephala*)
ilieʻe (*Plumbago zeylanica*)	mangrove (*Rhizophora mangle*)
ilima (*Sida fallax*)	natal redtop (*Rhynchelytrum repens*)
koali awahia (*Ipomoea indica*)	sourbush (*Pluchea symphytifolia*)
maia pilo (*Capparis sandwichiana*)	sour grass (*Digitaria insularis*)
makaloa (*Cyperus laevigatus*)	tree tobacco (*Nicotiana glauca*)
milo (*Thespesia populnea*)	spanish needle (*Bidens pilosa*)
naio (*Myoporum sandwicense*)	
pili grass (*Heteropogon conortus*)	
ruppia (*Ruppia maritime*)	
uhaloa (*Waltheria indica*)	
wiliwili (*Erythrina sandwicensis*)	

d) Blackburn's Sphinx Moth (Manduca blackburni)

Also present in these vegetation communities are native insects, the best known of which is Blackburn's sphinx moth (*Manduca blackburni*). Previously found in coastal and dry forests of the main Hawaiian Islands, this endemic Hawaiian sphinx moth is now known only on Maui and Lānaʻi islands. It was the first Hawaiian insect to be listed as endangered under the ESA. The Reserve contains portions of critical habitat for this moth (Richardson and Hopper 2003). The primary threats to the moth's habitat include development, fire, alien species, ungulates, and non-native parasatoids and insect predators. Actions to prevent this should include protection, management, and restoration of dry to mesic shrublands and forests, and native nectar-resource food plants for adult Blackburn's sphinx moths such as *maiapilo* and *S. coriacea*.

Figure 19. Maiapilo (*Capparis sandwichiana*), an endemic Hawaiian shrub (photo by Emily Fielding).

Table 17. Current status and threat ratings for native shrubland.

	Health Indicators Native Shrubland	Current Status	Threat Code	Threats Native Shrubland	Threat Rating
1N	Status of *wiliwili* stands	Poor	H1	Vehicular traffic (noise, emissions, congestion, wear and tear, off-road vehicles)	Low
2N	Diversity and trend status of native plant assemblages	Poor	A1	Potential of alien species introduction	High
3N	Extent of native plant assemblages	Poor	A2	Impact of existing introduced species(woody plant species growing around anchialine pools and archeological sites, native plant s competing with alien plants, introduced fish species, e.g. roi, ta'ape)	High
			A3	Native habitat damage by feral ungulates (browsing and trampling)	Very High
			A4	Decreased reproductive capacity (alien predation on native plant seeds; alien predation on water birds and seabirds, e.g. cats, mongoose)	Very High
			L3	Fire	Medium
			G1	Climate change and severe weather impacts to native biodiversity (habitat shifting and alteration, e.g. coral bleaching; severe lack of rain and temperature extremes; runoff from severe storms, ocean ph change)	High

1.4.7 Wilderness Qualities

☐ **Current status is Good**

a) Overview

The mandate for the Natural Area Reserves System states, "the legislature finds and declares that Hawaiʻi has unique natural resources, and that these should be protected and preserved for the enjoyment of future generations and to provide baselines about such natural resources "(HRS §195-1). Some qualities essential to protection and preservation of its natural resources are "wilderness" qualities. Conceptually, wilderness qualities can be broken down into two ways: 1) People-centric, where human needs for renewal and recreation are paramount, and 2) Eco-centric, where wilderness is safeguarded by a relative lack of human impact.

Under the Natural Area Reserves System, the approach is "eco-centric": Resources are valued and managed first for resource protection and preservation, and second for people and recreational purposes (DLNR 1997). These qualities, described below, include the tangible and measurable aspects that ensure the preservation of wilderness qualities and can be traced back to objective analysis provided by monitoring. Explicitly stating these qualities enables them to be monitored, thereby decreasing their susceptibility from neglect. Thus, these wilderness qualities can be attributed to and associated with preserving the ecology, landscape and the possibilities for "enjoyment of future generations." Primary threats to this conservation target include crowding from people, vehicular access, noise and lights, and surrounding and encroaching development.

Figure 20. Aerial view of ʻĀhihi Kīnaʻu Natural Area Reserve (photo by Tony Novak-Clifford).

b) Viewscapes of geologic formations and the cultural landscape

The Reserve and surrounding landscape serves as a paramount example of landscape conservation, protection, and cultural preservation. At any vantage point within the Reserve, sweeping, unobstructed views are available from the sea up to the volcanic vent, Kalua O Lapa, and further upward towards the southwest rift zone of Haleakalā and often to Hawaiʻi Island. Part of the preserved landscape within the Reserve allows for a glimpse into the geologic history of Maui and the processes by which the volcanic islands came to be. The land- and seascape

stand today very much as they have for millennia, and the places traveled by Hawaiian deities and ancestors can be viewed in their physical context. Furthermore, the seaward scenic vista of Kahoʻolawe, Molokini, Lānaʻi, Mauna Kahalawai (West Maui mountains) is magnificent to behold. This view presents the geologic history from one of the youngest flows to the older Maui Nui complex and the natural regenerative and erosional character of the landscape. For wildlife like seabirds and bats, the unimpeded landscape provides for habitat connectivity. Currently, the landscape is relatively free of structures and lights at night. The resulting low noise levels, dark nights, clear air and sea space, contribute to habitat quality for wildlife and a sense of beauty, remoteness or renewal for people.

Table 18. Current status and threat ratings for wilderness qualities.

	Health Indicators Wilderness Qualities	**Current Status**	**Threat Code**	**Threats Wilderness Qualities**	**Threat Rating**
1W	Viewscapes of geologic formations	Good	H1	Vehicular traffic (noise, emissions, congestion, wear and tear, off-road vehicles)	High
2W	Non-economic existence or intrinsic value	Good	H5	Human waste and trash	Medium
3W	Dark nights and clear air and sea space	Good	H6	Motorized ocean vessels in the reserve; anchoring	Medium
4W	Silence and a sense of isolation	Fair	A1	Potential of alien species introduction	Medium
			A2	Impact of existing introduced species(woody plant species growing around anchialine pools and archeological sites, native plant s competing with alien plants, introduced fish species, e.g. roi, ta'ape)	Low
			L1	Proposed adjacent coastal or upslope development (e.g. land-based pollution and nutrients and resulting alien algae growth, light pollution, altered wilderness qualities and viewplanes, hydrologic regime change)	High
			L2	Existing coastal development (Pollution and nutrients, lights at night, viewplanes)	Medium

2.0 The Action We Will Take

Thus far in this plan, we have discussed the setting, management context and history, threat analysis, and resources analysis. Going forward, Section 2.0 takes the working groups' and subject matter experts' best thinking on the information presented thus far, and proposes objectives and strategic actions to reduce the identified threats, increase the viability of priority target resources, and provide for information needs. This section also prioritizes objectives and strategic actions, provides sustainable finance mechanisms, a budget, and measures of success.

2.1 Management Framework

a) Adaptive management

The essential parts of this plan - action and measures - when applied in a systematic way, can be used to effectively manage biodiversity and other reserve values. We know that there is uncertainty and complexity inherent in managing natural ecosystems, and therefore we need to approach management with the understanding that we are learning (Nick Salafsky, R. Margoluis and K. Redford. 2001). In order to learn and adapt managers need to take special care with information. To aid in the management process, this plan aims to be explicit about: 1) what target resources we are conserving, 2) what the past, current and potential threats to those resources are, and 3) how we measure change. In the framework of this plan, managers will collect and analyze information as they implement actions so that expectations can be compared with actuality. As management progresses, they transform documented comparison into learning — they correct errors, improve our imperfect understanding, and modify action and plans.

Table 19. Purpose for establishment of Natural Area Reserves.

Hawai'i Revised Statutes [§195-1] Findings and declaration of necessity:

(1) the State of Hawai'i possesses unique natural resources, such as geological and volcanological features and distinctive marine and terrestrial plants and animals, many of which occur nowhere else in the world, that are highly vulnerable to loss by the growth of population and technology;

(2**) these unique natural assets should be protected and preserved, both for the enjoyment of future generations, and to provide base lines against which changes which are being made in the environments of Hawai'i can be measured;**

(3) in order to accomplish these purposes the present system of preserves, sanctuaries and refuges must be strengthened, and additional areas of land and shoreline suitable for preservation should be set aside and administered solely and specifically for the aforesaid purposes; and

(4) that a statewide natural area reserves system should be established to **preserve in perpetuity specific land and water areas which support communities, as relatively unmodified as possible, of the natural flora and fauna, as well as geological sites, of Hawai'i.** [L 1970, c

2.2 Our Vision, Mission, and Management Goals

a) Natural and cultural resources focus

The NAR System, as originally conceived, focuses on natural resource protection and enhancement. This plan builds upon this fundamental, legislative mandate and reflects the local recognition of the need to integrate natural and cultural resource management, as well as a broader shift in the approach and thinking of natural resource management efforts in Hawai'i, in moving away from a strict biological focus and toward an integrated biological and cultural focus. This new approach is clearly demonstrated within all aspects of the plan. This plan reflects another shift in resource management toward processes more inclusive of public involvement and driven through both multi-stakeholder and inter-organizational alliances. We also recognize that including stakeholders with diverse interests in the planning process is the best way to honor the natural resources and cultural heritage while strengthening preservation and conservation intentions.

b) A vision for the Reserve

The multi-stakeholder and inter-organizational management plan working group developed a vision for the Reserve focusing on respect and protection of natural and cultural resources, while emphasizing that human effort, in the form of *kōkua* (help) and *mālama* (care), is essential

(Working Group 2008). The phrase "*aloha ʻāina*" which literally means "love of the land or of one's country, is a very old concept to judge from the sayings (perhaps thousands) illustrating deep love of the land" (Pukui and Elbert 1986) and also expresses the intentions of the working group. The "mission" of the reserve is best reflected in Hawaiʻi Revised Statute 195-1, the mandate that established the Natural Area Reserves System.

c) Four goals

This management plan has four management goals that address priority management needs: 1) managing human uses, 2) controlling alien species and other biological threats, 3) preventing land-based impacts, and 4) building management capacity. Goals are brief, broad statements that relate to the vision and are simple to understand and communicate. Under each goal, we developed a set of objectives and strategic actions for implementation.

Table 20. Vision, mission and management goals.

Vision	**Through *kōkua* and *mālama*, the natural and cultural resources of ʻĀhihi-Kīnaʻu Natural Area Reserve are respected and protected as a living legacy. *Aloha ʻāina*.**
Goal 1. Manage Human (H) Use	We will manage human uses to protect natural and cultural heritage, and develop appreciation, understanding, and *kuleana* for the Reserve through education and interpretation.
Goal 2. Control Alien (A) Species and Other Biological Threats	The native biological community and cultural resource integrity of the reserve is strengthened and maintained by 2015 as the result of the successful control of alien species and other biological threats in terrestrial and aquatic habitats.
Goal 3. Prevent Land-based (L) Impacts	We will successfully control and prevent land-based impacts from source areas within, adjacent to and upland of the Reserve from having any significant, negative impact on the habitats, wildlife, and scenic resources found in the Reserve.
Goal 4. Build and Maintain the Reserve's Management (M) Capacity	We will build and maintain the partnerships, infrastructure, and human and financial resources necessary to support the Reserve's capacity to ensure effective site management through time.

2.3 Goals, Objectives and Strategic Actions

a) Objectives

Objectives are specific and measureable statements of what we hope to achieve in the Reserve. They represent our assumptions about what needs to be done based on current status and condition of targets and provides us with the capabilities for measuring and gauging our progress towards a successfully managed Reserve. Most importantly, the 14 Reserve objectives focus on abating the most critical threats, enhancing resource viability, and building

management capacity.

b) Strategic actions

Each of the objectives addresses a management need, and is implemented by following a set of strategic actions. The 48 strategic actions in this plan are focused, feasible, and appropriate courses of action to be carried out by the Reserve staff, a project team, or through partnerships or contract. A summary table of objective and actions in provided at the end of this section. This plan does not have specific work plans or budgets by action, rather it provides the guidance needed to produce implementation plans.

The scope of this comprehensive plan is larger than current management resources could successfully implement. However, reducing the plan to only what is achievable by the department alone would do little to address or abate current threat levels. Implementation of this plan requires substantial support by other state departments, DLNR divisions, federal agencies, non-governmental organizations (NGOs), Advisory Group members, contractors, and other sectors. As discussed in 1.2.2 Management History, key partners have played important roles in the past and are expected to continue to support effective resource management.

2.3.1 Goal 1. Manage Human (H) Use

We will manage human uses to protect natural and cultural heritage, and develop appreciation, understanding, and *kuleana* for the Reserve through education and interpretation.

Objective H1 – Reduce the Negative Impacts of Visitors and Increase Safety

By 2012, we will reduce the frequency of negative impacts caused by visitors by half (from 2007 levels) within specified priority natural and cultural (terrestrial and marine) resource areas in the Reserve. A downward trend in such negative impacts will continue through 2015.

Strategic Actions

Action H1(a) – **Set and manage visitor limits and access points.**

Tasks include: (i) assess existing human use data and characterize visitor access and activities in the Reserve, and establish two zones (limited-open and restricted access as seen in Figure X)*; (ii) establish and enforce visitor limits, set vehicular quotas based on existing data set and augmented by additional study as needed; (iii) enhance visitor parking facilities within specified limits where Reserve parking is allowed only at the Reserve's Entry and Kanahena Parking Area, and not at Kanahena Cove or roadside); (iv) enhance management of visitor waste through assessment, improvement and maintenance of solid and human waste facilities at access points. **NARS rule change may be required*

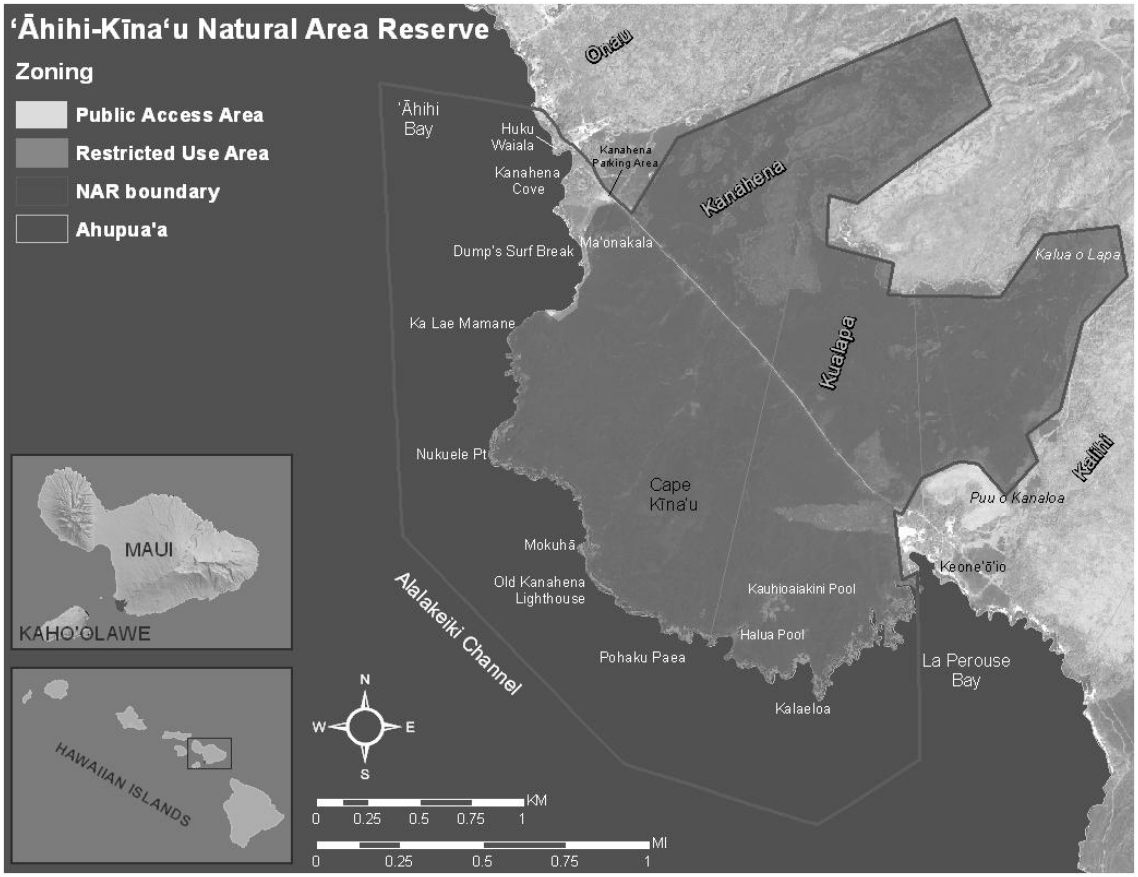

Figure 21. Map of zoning proposed in this plan under Action H1(a).
**The management plan working group recommends that the temporary two-year zoning be made permanent, with limited guided walks and service projects into restricted areas. This zoning and associated programs, decreases resource impacts, increases human safety, limits access and increases appreciation and support for open area, provides service and volunteer opportunities, and guided educational walks.*

Action H1(b) – **Effectively enforce use regulations, by zone.**

Tasks include: (i) in collaboration with DOCARE and MPD, improve enforcement of Reserve regulations of commercial, cultural, and recreation uses within designated zones and operational hours (particularly to address illegal fishing, habitat trampling and cultural resource degradation, and proper solid and human waste disposal); (ii) review, assess, and increase fines and penalties for violations, as needed; (iii) improve visitor/user awareness of established regulations and promote low-impact behavior through informational materials and a "good stewardship etiquette while visiting" program (see also Objective H3); (iv) install technologies that allow for remote surveillance and documentation of motorized marine activities, such as submerged acoustic monitoring stations (EARs); (v) gather and compile data on enforcement and compliance to track trends and inform efforts; (vi) enforce temporary closures of areas when Hawaiian monk seal or sea turtle is on shore.

Action H1(c) – **Establish and maintain visitor entry and passage systems.**

Tasks include: (i) establish and maintain a state-of-the-art visitor trail (terrestrial) system limited to readily accessible, low-risk areas in the open zone; (ii) in the open zone, establish interpretive areas and informational materials along self-guided trails and visitor

congregation sites (e.g., parking lots, access gates); (iii) in the restricted access zone, establish and coordinate ranger guided interpretive hikes along established trails in accordance with a user fee schedule (see also Objective H3); (iv) improve visitor awareness and navigation of Reserve boundaries through boundary modifications designed to simplify navigation and promote compliance (particularly within La Pérouse Bay); (v) decrease illegal motorized vessel entry and passage by installation of visible markers on land and sea; (vi) improve awareness of biologically- and culturally-appropriate, low-impact visitor behavior through informational materials and a "good stewardship etiquette while visiting" program (see also Objective H3); (vii) establish a marine trail system to direct visitors to entry and exit locations and underwater places that are interesting and will not cause habitat decline.

Action H1(d) – **Gather relevant information regarding visitor levels and user behavior.**
Tasks include: (i) design a human use monitoring protocol to periodically collect visitor levels, behaviors, impacts, and relevant user information using accepted methods; (ii) periodically conduct human use monitoring in a timely manner; (iii) collect, enter, manage, and analyze human use data to improve our understanding of human use trends and inform management decision-making.

Action H1(e) – **Review and adjust Reserve boundaries as needed.**
Tasks include: (i) establish a working group of the Advisory Group to assess and review current marine and terrestrial boundary definition and effectiveness; (ii) as necessary, relevant, and defined, recommend for BLNR review and approval the adaptation of Reserve boundaries to maximize management effectiveness.

Action H1 (f) – **Minimize the impacts of unexploded ordinance.**
Tasks include: (i) work closely with the Army Corp of Engineers to minimize impacts of unexploded ordinance removal to reserve resources, and staff and public safety.

Objective H2 – Protect and Stabilize Cultural Resource Sites

By 2012 we will protect, stabilize, and maintain the integrity of at least three high priority cultural resource sites inside and adjacent to the Reserve.

Strategic Actions

Action H2(a) – **Identify the most threatened cultural resource sites requiring protection.**
Tasks include: (i) establish a knowledgeable and respected cultural resource working group (through the Advisory Group), comprised of cultural practitioners, community leaders, and technical experts (archeologists, historians); (ii) assess the type and level of threats facing archeological sites utilizing the 2007 Cultural Resources Management Plan; (iii) document the frequency, type, and level of negative visitor impacts made on cultural resource sites, whether unintentional, intentional and non-destructive, or intentional and destructive (vandalism, looting); (iv) document the frequency and type of negative invasive species impacts made on cultural resource sites, particularly relating to feral ungulate behavior and alien invasive plant species; (v) compare threat levels among sites and identify the most threatened sites requiring immediate protection.

Action H2(b) – **Implement protection and stabilization plans for high priority cultural resource sites.**

Tasks include: (i) identify the archeological sites of highest cultural significance based on recommendations made by the cultural resource working group, based on the assessment in Action H2(a); (ii) design and implement archeological stabilization plan and monitoring to protect high priority cultural resource sites; (iii) initiate management actions specific to site needs which may include greater ranger presence, rerouting of pedestrian trails, feral ungulate exclusion fencing; limiting human access and use (signage at accessible sites to guide appropriate visitor behavior, or more detailed documentation and mapping of site); (iv) apply for federal designation of priority cultural resource sites under the Archeological Resources Protection Act.

Action H2(c) – **Establish and enforce rules to govern appropriate visitor behavior.**

Tasks include: (i) through the cultural resource working group, establish guidance and or rules governing appropriate visitor behavior at cultural resource sites in the Reserve, including penalties for violators whether unintentional, intentional and non-destructive, or intentional and destructive (vandalism, looting); (ii) provide information and raise visitor awareness of appropriate visitor behavior and cultural resource rules and regulations (see also Objective H3); (iii) in collaboration with DOCARE, enforce regulations with those who have negative impacts on cultural resource sites and items.

Action H2(d) – **Inventory all archeological sites found within and adjacent to the Reserve.**

Tasks include: (i) complete inventory-level survey and recording of all archaeological sites previously undocumented within Reserve boundaries (Archeological Inventory Survey); (ii) detailed mapping and site descriptions of known priority and/or high-visitation archaeological sites within and immediately adjacent to the Reserve, including the Keoneʻōʻio anchialine pool/inlet complex and Maʻonakala Village Complex; (iii) mapping and historic use investigation of subterranean anchialine pool and lava tube systems; (iv) recommendations made for preservation and monitoring of priority archaeological sites within and immediately adjacent to the Reserve.

Objective H3 – Preserve Knowledge and Promote Awareness of the Reserve

By 2012 the number of Maui visitors and regional residents who are aware of and have knowledge about the biological and cultural importance of the Reserve will increase 300% from 2007 levels.

Strategic Actions

Action H3(a) – **Establish an information and interpretation program.**

Tasks include: (i) develop an interpretation and outreach plan which addresses management needs and resource considerations while building a *kuleana* and *mālama ʻāina* ethic for the Reserve among visitors and residents; (ii) utilize professional services to design the interpretive components (themes, messages, content, delivery, etc.) and desired

outcomes and behaviors; (iii) planning process would utilize the expertise of the Advisory Group, its working groups, subject matter experts and Reserve staff.

Action H3(b) – **Implement and operate a volunteer program**.
Tasks include: (i) under the interpretation plan, develop a state-of–the-art program to train, supervise, and recognize volunteers that assist in the implementation of program goals, including broadening community support of caring for the natural and cultural resources of the Reserve.

Action H3(c) – **Promote cultural awareness to understand regional significance and establish a sense-of-place.**
Tasks include: (i) conduct an in-depth cultural landscape study of available archival sources, including stories, songs, maps, Hawaiian language newspapers, and other historic documents; (ii) interview and document oral histories of lineal descendants with *kuleana* over Reserve lands and other knowledgeable island residents; (iii) research and document fishing and other resource harvesting/gathering traditions of area; (iv) integrate the cultural and historic material into interpretive program and training for staff and volunteers.

2.3.2 Goal 2. Control Alien (A) Species and Other Biological Threats

The native biological community and cultural resource integrity of the reserve is strengthened and maintained by 2015 as the result of the successful control of alien species and other biological threats in terrestrial and aquatic habitats.

Objective A1 – Control Ungulate Populations

By 2015, we will have reduced the abundance of feral (goats and pigs) and introduced (deer) ungulates from native terrestrial habitat and cultural sites within the Reserve to 80% of their estimated 2010 population sizes.

Strategic Actions

Action A1(a) – **Improve our understanding of ungulate impacts and controls.**
Tasks include: (i) complete a survey to estimate ungulate (deer, goats, pigs) population numbers and assess habitat use patterns and impacts; (ii) conduct periodic monitoring of ungulate populations and behavior; (iii) identify preferred animal removal techniques and process within DLNR guidelines; (iv) identify sites with a high potential for native habitat restoration following use of proposed ungulate controls; assess how existing roads, substrate, stream courses, cultural sites, and other physical factors would influence fence line construction; (v) prepare draft environmental assessment (EA), including map of proposed fence line and cost estimate for various fencing scenarios on TMK boundary on lava; (vi) share new understanding, EA recommendations, and secure BLNR and DLNR approval on planned ungulate control (deterrence, removal, and exclusion) process and EA.

Action A1(b) – **Deter and remove ungulates out of the Reserve.**
Tasks include: (i) complete short-term deterrent and removal efforts around impacted priority cultural resource sites within DOFAW guidelines; (ii) based on evaluation of deterrence and removal efforts, assess utility and feasibility of employing these controls on

a wider scale throughout the Reserve; (iii) prepare and provide public outreach materials that illustrate the humane nature of ungulate deterrence and removal efforts used; (iv) install fence per EA and best management practices for terrain and ungulate types; (v) following installation of Reserve-wide exclusion fence efforts, remove all ungulates, monitor for any continued ungulate presence within Reserve boundaries.

Action A1(c) – **Exclude ungulates from entering the Reserve.**

Tasks include: (i) in the short-term, identify representative areas of native forest and shrubland habitat negatively impacted by ungulates within the Reserve; (ii) within three high-priority areas of both habitat types, immediately exclude ungulates over the short-term by installing fencing around small enclosures; (iii) by 2015, permanently exclude all ungulates by installing fencing around the entire Reserve boundary/perimeter; (iv) monitor and maintain perimeter fence line around the Reserve.

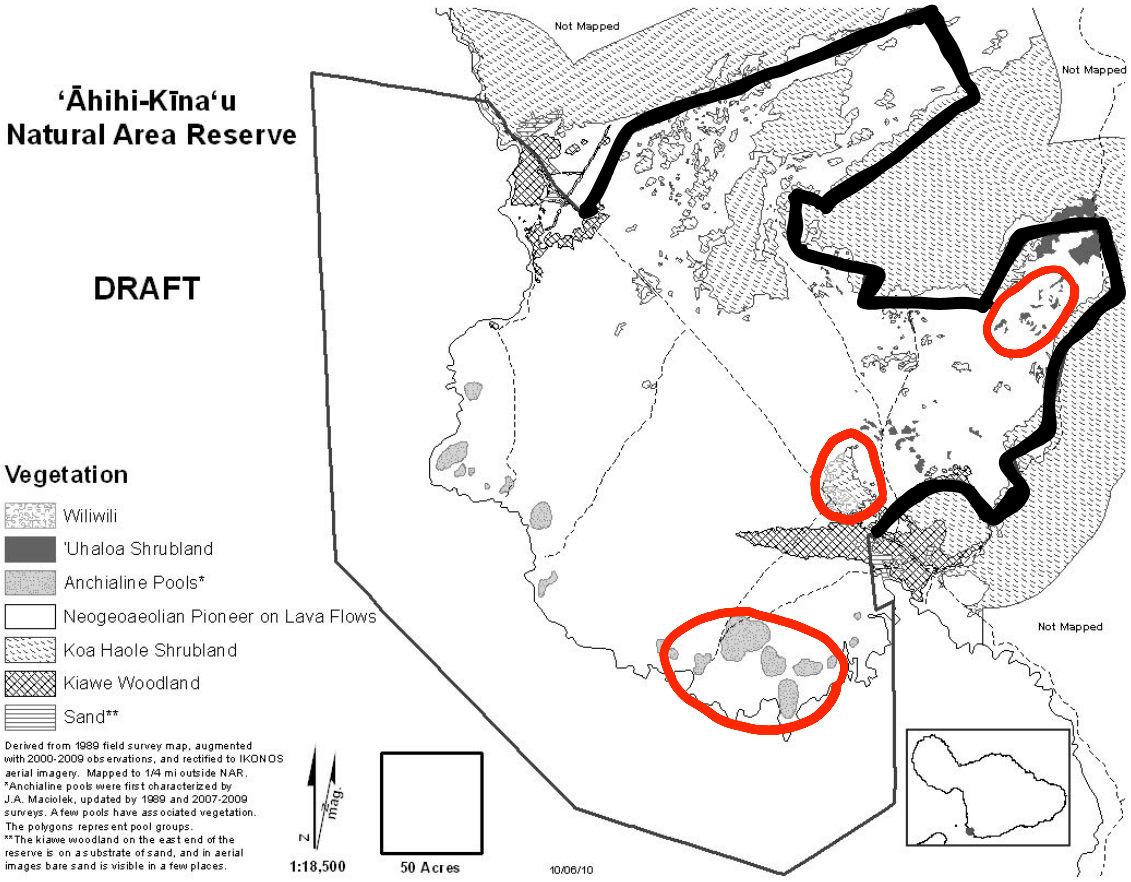

Figure 22. Reserve map showing the three high priority sites for immediate ungulate exclusion A1(c) and restoration A4(a) encircled in red (*awikiwiki, wiliwili,* and *anchialine pool*); and proposed ungulate exclusion fence A1(a) and A1(b) outlined in thicker black (map by Stephanie Tom and Roxie Sylva).

Objective A2 – Control Priority Alien Plants and Animals in Terrestrial Habitats

At high-priority native terrestrial habitat restoration sites, by 2015 we will have reduced the population density of top alien invasive plants and animals by at least 50%.

Strategic Actions

Action A2(a) – **Remove predatory animals from around priority anchialine pools and seabird nesting areas.**

Tasks include: (i) initiate a program to periodically trap and remove mammals (e.g. rats, mongoose, cats, dogs, cattle egrets) that prey on the eggs, young, and adults of native waterbird populations that nest on/use anchialine pool habitats (including Kauhioaiakini); (ii) set-up a program to intercept and remove predators starting each year just before the breeding season (March) and continuing through August (or when the last chicks are flighted); (iii) monitor the effects of reduced predators on native waterbird populations and nesting areas, monitor predator activity, bird demography and breeding success; (iv) control and maintain low to no levels of predatory mammal presence at high-priority anchialine pool sites; (v) survey to determine presence/absence and location of nesting seabirds, automated vocalization recording devices should augment the studies, and specific management strategies should be based on results of studies; (vi) based on evaluation of removal efforts for anchialine and coastal areas, assess utility and feasibility of employing these controls on a wider scale and/or throughout other habitat types (native forest and shrubland) in the Reserve; (vii) prepare and provide public outreach materials that illustrate the humane nature of predator removal efforts used and benefits to native species.

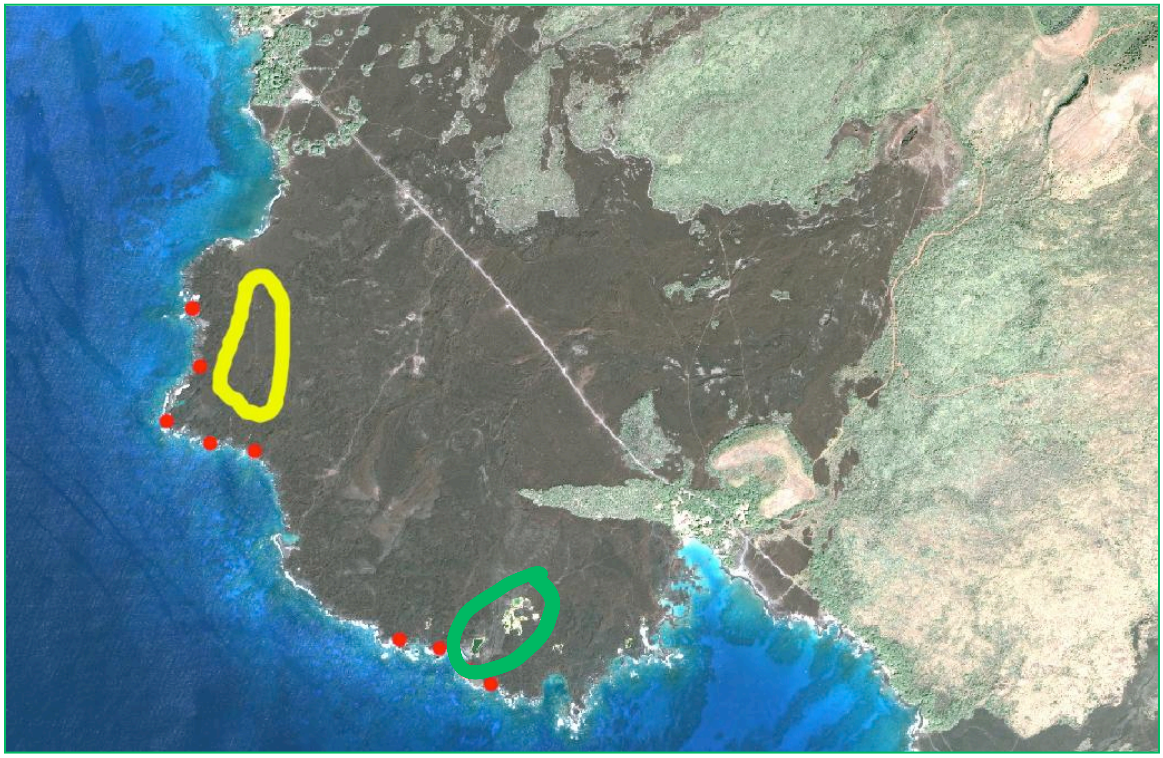

Figure 23. Reserve map showing habitat restoration areas for native waterbirds (in green) and seabirds (in yellow) A2(a) & A2(b). Red dots represent where the seabird survey locations were conducted (map by Matt Ramsey and Roxie Sylva).

Action A2(b) – **Reduce alien plant populations in native habitats.**

Tasks include: (i) initiate a program to remove alien invasive plant species in three representative areas of high-priority lava flow or shrubland habitat needing active restoration identified also in Actions A1(c) and A4(a); (ii) maintain anchialine pool aquatic community integrity through the careful removal of alien invasive sourbush, sour grass, pickle weed, mangrove, and woody plants from and around pools and completely remove alien vegetation from site; (iii) monitor and control recruitment of alien invasive seedlings through time; (iv) develop and explore effective methods for landscape monitoring of vegetation structure and composition in lava flow, shrublands, and anchialine areas of the reserve.

Action A2(c) – **Reduce alien invasive insect populations in native habitats.**

Tasks include: (i) monitor effects of bio-control on alien invasive gall wasps and on *wiliwili* trees in native forest and shrubland habitat within the Reserve; (ii) establish and specific management strategies based on results of studies; (iii) conduct baseline inventory to document presence/absence of other harmful alien invertebrates.

Action A2(d) - Prevent new alien introductions.

Tasks include: (i) establish a mechanism for rapid response to eliminate new introductions at the incipient species level; (ii) continue to identify other high priority alien or other biological threats for early detection and further study using MISC priority species determinations. These are reviewed as needs/discoveries arise and tied to incipient species which are most economically and efficiently controlled.

Objective A3 – Control Priority Alien Organisms in Aquatic Habitats

Within coral reef and anchialine pool habitat in the Reserve, by 2015 we will have reduced the population density of the priority alien fish and aquatic plant species by at least 50%.

Strategic Actions

Action A3(a) – **Remove predatory fish from coral reefs and anchialine pools.**

Tasks include: (i) initiate a program to remove alien invasive roi (peacock grouper) within a designated removal zone (to be determined) on coral reef habitat within the Reserve together with adequate data collection methods; (ii) monitor and maintain suppression of resident roi population to low or no individuals within the removal zone through time; (iii) quantify effects of roi removal to inform future management action to be taken in the Reserve ; (iv) initiate a capture and relocation program to remove introduced marine and brackish water fish species from anchialine pools and relocate them to adjacent reef areas, as necessary.

Action A3(b) – **Detect alien algae density and emerging threats on coral reefs and anchialine pools.**

Tasks include: (i) conduct periodic monitoring of marine intertidal areas for alien algae according to interagency standards for early detection; (ii) conduct periodic monitoring of anchialine aquatic ecosystems according to interagency standards for early detection of the spread of alien invasive plant and animal species, as well as other changes, and to provide

information for trends and for comparison to other pool sites in Hawai'i; (iii) conduct periodic monitoring for coral bleaching and disease, crown-of-thorns sea stars and marine invasive species in accordance with interagency standards; (iv) coordinate rapid response to identified threats with appropriate agencies and partners; (v) continue to identify other high priority marine threats for early detection and further study.

Action A3(c) **– Investigate the most effective ways to address aquatic invasive and emerging threats.**

Tasks include: (i) initiate an investigation into the trends and status of diseased coral, diseased fish, and crown-of-thorns sea stars' outbreaks within the Reserve; (ii) explore ways to address threats.

Objective A4 – Actively Restore Native Plant and Wildlife Assemblages

By 2015, we will have successfully implemented a native habitat restoration plan for the Reserve that results in the restoration of at least 5 acres within both native shrubland and lava flow habitats.

Strategic Actions

Action A4(a) – **Replant native species at test sites in anchialine and shrubland habitat.**

Tasks include: (i) identify three representative areas of high-priority native habitat needing active restoration (same sites as identified in A1(c) and A2(b)); (ii) within these priority test sites, initiate a program to replant native plants and reestablish a native plant assemblage with a species composition and diversity of native plants that best reflects a native community, based on best available information and expert opinion; (iii) monitor and document survivorship rates, species diversity, and successional changes observed for restored native plant assemblages at these sites; (iv) maintain restored native plant assemblages and remove alien invasive plant recruits from test sites.

Action A4(b) – **Implement a native habitat restoration plan for the Reserve.**

Tasks include: (i) conduct a survey to characterize the status of native plants, native invertebrates and native wildlife within the Reserve (including spatial extent) and compare results to 1989 baseline survey; (ii) develop a native shrubland and lava flow habitat restoration plan, incorporating lessons from native ecosystem restoration efforts at priority representative sites; (iii) manage for seabirds when appropriate findings are made according to Maui Endangered Seabird Project best management practices; (iv) implement the restoration plan where relevant within the Reserve; (v) monitor and maintain restored native plant assemblages and remove alien invasive plant recruits; (vi) conduct research on historical trends regarding biotic and climatic changes within the region and study regional analog ecosystems that provide a window into the past.

2.3.3 Goal 3. Prevent Land-based (L) Impacts

We will successfully control and prevent land-based impacts from source areas within, adjacent to and upland of the Reserve from having any significant, negative impact on the habitats, wildlife, and scenic resources found in the Reserve.

Objective L1 – Maintain High Coastal Water Quality

By 2015, coastal water quality within the Reserve will meet or exceed state standards for class AA waters.

Strategic Actions

Action L1(a) – **Prevent or minimize sources of land-based pollution into the Reserve waters.**

Tasks include: (i) assess and identify primary point and non-point source contributions of land-based pollution into the Reserve waters, including nutrient loading and soil erosion from up-slope development; (ii) review and choose appropriate best management practices (BMPs) to be employed within and adjacent to the Reserve to prevent or minimize these sources; (iii) implement BMPs to address pollutant sources.

Action L1(b) – **Upgrade sewage systems within and adjacent to the Reserve.**

Tasks include: (i) characterize nature of current sewage holdings and systems; (ii) upgrade existing cesspools to septic tank systems as necessary; (iii) maintain visitor restroom facilities and sewage systems in an environmentally responsible manner; (iv) explore possible use of alternative sewage system technologies for application within the Reserve.

Action L1(c) – **Educate neighbors on pollutant impacts and reduction efforts.**

Tasks include: (i) develop and disseminate outreach products for neighbors and residents upland of Class AA waters with relevant messages about reducing pollutant and nutrient loads on landscape, upgrading sewage systems, and other efforts to minimize pollution.

Action L1(d) – **Monitor water quality for coral reefs within the Reserve's waters.**

Tasks include: (i) conduct periodic water quality monitoring at sampling stations in the Reserve waters; (ii) initiate a community volunteer water quality monitoring program; (iii) conduct periodic marine debris removal along the reserve coastline with volunteers.

Objective L2 – Reduce Upland Development Impacts

By 2015, negative upland development impacts on the Reserve's natural and cultural resources will be largely reduced or fully mitigated through the use of various strategies to restrict land use.

Strategic Actions

Action L2(a) – **Designate and prevent development within a Reserve buffer zone.**

Tasks include: (i) Review, amend, or establish best management practices for land use practices within the lands adjacent to the Reserve's boundaries; (ii) assess the land ownership interests within a 1-mile radius surrounding the Reserve's boundaries by TMK and land use zoning status; (iii) prioritize land management actions according to proximity,

feasibility, and potential for impact to resources; (iv) design and propose an approximately 1-mile buffer zone surrounding the Reserve's boundaries within which land development activities are minimized and seek to have this accepted and approved by county and state authorities; (v) where possible, purchase, seek conservation easements on, or rezone lands encompassed within proposed 1-mile buffer zone; (vi) work with state and county authorities to ensure a high level of scrutiny on Special Management Area (SMA) permit applications in the buffer zone.

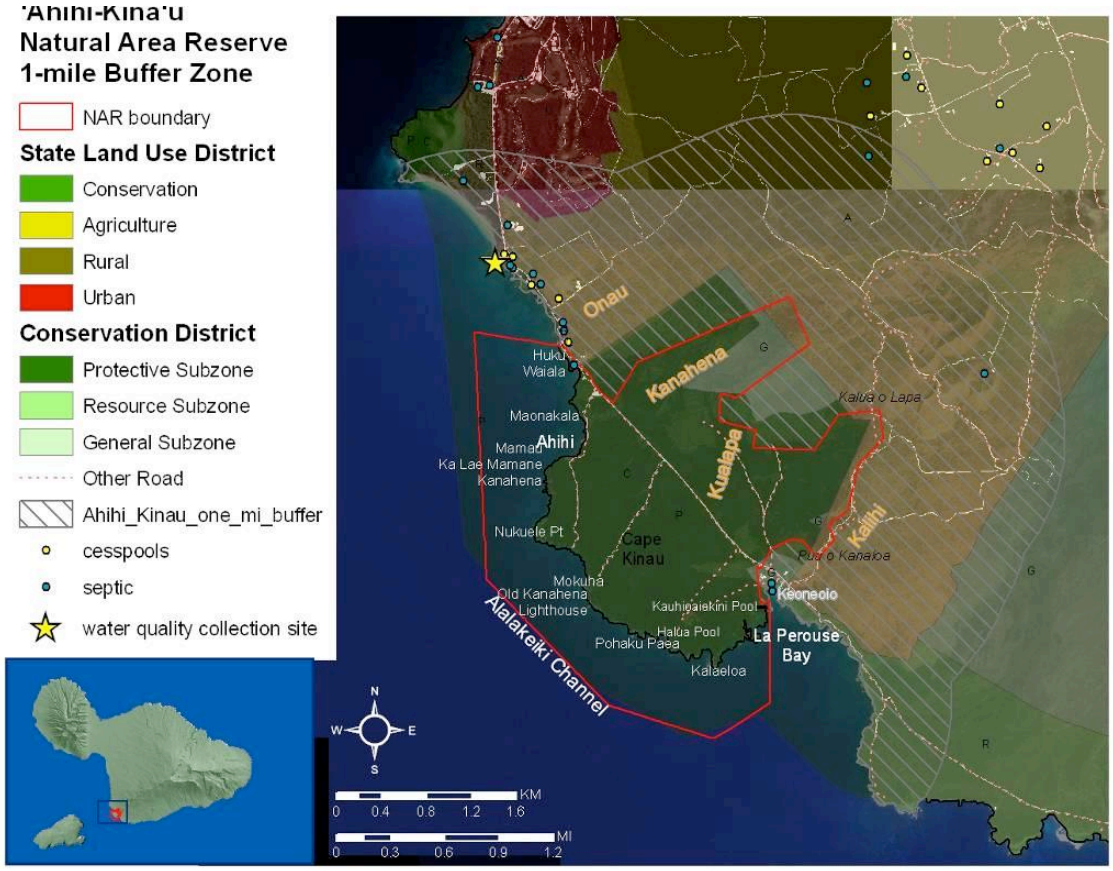

Figure 24. A one mile buffer around the Reserve and associated state land use districts. (map by Stephanie Tom).

Action L2(b) – **Review and influence progress on proposed development projects.**
Tasks include: (i) utilize and strengthen existing state and county development project permit review and approval processes in order to be notified about and comment on planned development efforts on lands neighboring the Reserve; (ii) contribute to the development of a permit review process so that planned development within neighboring properties is conducted in a manner that maintains the cultural and ecological integrity of the Reserve's resources while adhering to conservation and agricultural land zoning requirements and building codes.

Action L2(c) – **Acquire and hold adjacent lands and infrastructure.**
Tasks include: (i) seek the support of the Natural Area Reserves Systems Commission (NARSC) and BLNR to advocate for NAR addition or expansion into eligible adjacent lands;

(ii) through purchase, trade, and/or conservation easements, acquire and hold lands important to the Reserve in order to prevent development from occurring; (iii) begin discussions with landowners within the Reserve to acquire in-holdings, and with owners of infrastructure (i.e., electric lines) about the possible return to a more natural state over time.

Objective L3 – Prevent or Minimize Manmade Light Pollution Within Reserve Boundaries

By 2015, nighttime light levels within the Reserve will not exceed naturally-occurring levels so as to prevent alteration or disruption of native wildlife nocturnal behavior.

Strategic Actions

Action L3(a) – **Prevent or minimize sources of manmade light pollution.**
Tasks include: (i) determine natural ambient light levels at night within Reserve boundaries and if those levels exceed county lighting ordinances; (ii) assess and identify primary sources of light pollution that contribute to altered/elevated ambient light levels; (iii) implement best management practices that prevent or minimize light sources exceeding natural ambient light levels at night within Reserve boundaries; (iv) monitor and maintain ambient light levels within the Reserve at near or naturally-occurring levels at night.

Action L3(b) – **Educate neighbors on light pollution impacts and reduction efforts.**
Tasks include: (i) develop and disseminate outreach products for neighbors with relevant messages about the need for reducing light pollution to naturally-occurring ambient light levels at night, and how to take local actions to do so.

2.3.4 Goal 4. Build and Maintain the Reserve's Management (M) Capacity

We will build and maintain the partnerships, infrastructure, and human and financial resources necessary to support the Reserve's capacity to ensure effective site management through time.

Objective M1 – Secure and Sustain the Level of Human and Financial Resources Needed

By 2015, the state, county, and supporting partners will have worked together to successfully secure all necessary human and financial resources to fully implement and sustain all minimum and most desired management activities under the approved management plan.

Strategic Actions

Action M1(a) – **Implement a Reserve sustainable financing plan by 2011.**
Tasks include: (i) work with the Advisory Group, partner organizations, donors, and the public to develop and implement a sustainable financing plan that outlines three financing scenarios for the minimum, desired, and idealized annual budgets under the management plan; (ii) implement the financing plan and secure the necessary sources of annual revenue

to meet at least the minimum financing scenario, annually; (iii) create and grow an endowment mechanism to support the annual costs of the Reserve's management into the future.

Action M1(b) – **Hire a full-time Reserve manager by 2011.**
Tasks include: (i) work with the state, Advisory Group, and supporting partner organizations to identify how a full-time Reserve manager position would be financed, administered, and hired; (ii) develop and advertise a job description for the position and recruit the best candidate; (iii) hire and implement the full-time position by mid-2011.

Action M1(c) – **Build the technical capacity of the professional ranger program.**
Tasks include: (i) formally establish a professional ranger team for the Reserve; (ii) assess team size and skill level/abilities of current ranger team, including biological and human use monitoring; (iii) make adjustments to size (expansion) and capacity (build specific skill sets) of ranger team, as necessary; (iv) create a mechanism to enhance the frequency and duration of ranger-visitor interactions (beyond rule enforcement and monitoring) and regular outreach events with regional residents; (v) initiate and promote deputy (community volunteer) ranger program for regional residents in both terrestrial and marine settings (see also Objective H3); (vi) site managers and rangers undergo cultural sensitivity training in their management and enforcement of cultural resources.

Action M1(d) – **Establish a Reserve user fee program.***
Tasks include: (i) conduct a feasibility study aimed at the intention of establishing a Reserve user fee program to fund a portion of the Reserve's management and interpretation program activities; (ii) obtain public support for the proposed user fee program through assistance by the Advisory Group, local community partners, and partner organizations; (iii) obtain state and county permission and support for implementation of the user fee program; (iv) implement the user fee program and initiate process to collect and manage revenues generated. *NARS rule change may be required

Action M1(e) – **Empower and strengthen the Advisory Group.**
Tasks include: (i) continue to support the Advisory Group to provide a public forum for discussion of management of the Reserve and regional resources and to support plan implementation; (ii) build the administrative capacity of the Advisory Group through strategic membership recruitment, provision of timely administrative and convening/facilitating support by partner organizations for regular (quarterly) Advisory Group meetings, and Advisory Group effectiveness trainings and capacity building of Advisory Group members; (iii) obtain state and county authority and recognition of the responsibilities and roles of the Advisory Group within the implementation and evaluation of the Reserve management plan.

Objective M2- Provide Biological Resource Status Information for Management

By 2015, the state, federal, and supporting partners will have worked together to successfully secure the necessary human and financial resources to periodically monitor the status of all priority biological resources in the Reserve.

Strategic Actions

Action M2(a) – **Conduct biological status monitoring of terrestrial resources.**

Tasks include: (i) periodically monitor the status and trends of native plant assemblages, invertebrates in lava-tube caves, new lava, anchialine pools, littoral areas, and shrublands; (ii) monitor the demography, status and trends of seabirds and waterbirds following baseline surveys and restoration plan development in Action A4(b).

Action M2(b) – **Conduct biological status monitoring of aquatic resources.**

UTasks includeU: (i) continue DAR and Coral Reef Assessment and Monitoring Program (CRAMP) at two sites, Kanahena Point and Kanahena Cove, to track status of coral reef health and trends; (ii) continue DAR fish surveys at five sites which includes one integrated fish and benthic survey site within the NAR, and one integrated site within Keoneʻōʻio bay; fish surveys are conducted 3 times per year; (iii) continue periodic monitoring of marine intertidal areas for ʻopihi, other invertebrates and algae to track status and trends according to establish standards; (iv) continue periodic monitoring of anchialine aquatic ecosystems for trends and status according to interagency standards.

Objective M3 – Provide On-Site Infrastructure to Meet Management Needs

By 2014, the state, county, and supporting partners will have worked together to successfully build and maintain the necessary on-site infrastructure to fully implement and sustain all minimum and some desired management activities under the approved management plan.

Strategic Actions

Action M3(a) – **Complete the Reserve's facility and infrastructure planning.**

Tasks include: (i) by 2011, conduct an assessment of the existing Reserve's facility and infrastructure levels and future needs in order to implement the approved management plan; (ii) by 2012, complete a short-term (2012–2015) and long term (2015–2025) facilities and infrastructure masterplan to meet management plan needs (including visitor access controls, visitor facilities provision, interpretive and educational programs, and office and equipment space for on-site operations by Reserve staff), and taking into account neighboring Mākena State Park Planning considerations and possible Kanaio Natural Area Reserve expansion efforts; (iii) by 2014, obtain rulemaking agreement and sign-off by state and county authorities to implement short- and long-term facilities and infrastructure masterplans; (iv) during 2014, implement masterplans to build and maintain necessary facilities, infrastructure, and equipment (e.g., vehicles, ranger equipment, trail maintenance equipment, and digital, radio, and telecommunication).

Action M3(b) – **Improve and maintain Reserve access gates and roads.**

Tasks include: (i) obtain a memorandum of agreement (MOA) among state and county authorities on access, maintenance, enforcement, and liability for the single lane road through the Reserve; (ii) as per the MOA, improve and maintain the Reserve's roads; (iii) install and establish gates and guard/toll stations to control and maintain set visitor quotas (see Goal 1).

Action M3(c) – **Improve and maintain the Reserve's visitor facilities.**
Tasks include: (i) as per the masterplan, improve and maintain visitor facilities within the Reserve, including parking, lavatories, informational stations and interpretive areas; (ii) install infrastructure to provide the necessary access to digital, radio, and telecommunication needs.

Action M3(d) – **Improve and maintain the Reserve's waste management.**
Tasks include: (i) as per the masterplan, improve and maintain waste management facilities for visitors and staff within the Reserve; (ii) implement a waste management awareness and education program for the Reserve's visitors.

Action M3(e) – **Improve and maintain ranger stations and staff offices.**
Tasks include: (i) as per the masterplan, improve and maintain ranger stations and staff office facilities within the Reserve.

Objective M4 – Initiate and Maintain Strategic Partnerships

By 2015, a full suite of federal, state, county, non-government, and community partners will have been recruited and actively engaged in the Reserve's management and financing process.

Strategic Actions

Action M4(a) – **Identify strategic partnership needs under the plan.**

Action M4(b) – **Recruit partners in support of the plan's implementation.**

2.3.5 Strategic Courses of Action and Use of Results Chains

a) Strategies employed in the conservation of Reserve resources

The objectives and actions listed under each of the four goals follow standard strategies used in conservation action throughout the world. In fact, each of the14 objectives and 48 actions to address threats can be distilled down to the seven strategy categories listed in the table below. Inventory and monitoring are considered measures of the effectiveness of a strategy or of the status of resources, and therefore are not included on this list of common strategies used in this plan.

Table 21. Threats concerning each strategy.

Strategy	Related Objectives	Priority Actions	Threats Addressed
Zoning (ZON)	H1, L2, M2	H1a, H1c, H1f, L2a, M2b	Recreation Degradation
Enforcement (ENF)	H1, H2	H1b, H1c, H1d, H2c	Recreation Harvest
Education (EDU)	H1, H3, A2, M1, M2, M3	H1c, H1d, H3a, H3b, A2a, L1c, L3b, M1a, M1b, M1c, M1d, M2a, M2c, M2d, M2e, M3a, M3b	Recreation Capacity
Extraction (EXT)	A1, A2, A3	A1b, A2a, A2b, A2c, A3a	Invasive Degradation Pollution
Development (DEV)	L2	L2a, L2b, L2c	Pollution
Restoration (RST)	H1, H2, H3, A1, A2, A3, A4, L1, L3	H1e, H2a, H2b, H2d, H3c, A1a, A1c, A2b, A2c, A3b, A3c, A4a, A4b, L1d, L3a	Degradation
Management (MGT)	H1, L1, L2, M2	H1d, L1a, L1b, L2a, L2c, M2a, M2b, M2c, M2d, M2e	Development Pollution

b) Results Chains

A Results Chain is a simple method used to help clarify our assumptions about how conservation strategies contribute to reducing threats and achieving the conservation of specific targets. This tool provides a way to visualize how the strategic actions lead to the outcomes we've identified in the goals and objectives.

Results Chains define how we think a project strategy or activity is going to contribute to reducing a threat and conserving a target. It focuses on the achievement of results, not the execution of activities. Importantly, it is composed of assumptions that can be tested, indicators of success and time-frames.

We've provided four priority Results Chains in the appendix for the strategies of education (EDU), enforcement (ENF), extraction (EXT), and zoning (ZON).

1. Results Chain for the strategy of Education (EDU) to address recreation (REC) and management capacity (CAP) needs.

2. Results Chain for the strategy of enforcement (ENF) to address recreational (REC) and illegal harvest (HRV) threats.

3. Results Chain for the strategy of extraction (EXT) of alien or invasive (INV) to address threats of resource degradation (DEG) and pollution (POL).

4. Results Chain for the strategy of zoning (ZON) to address threats from recreation (REC) and resource degradation (DEG).

Table 22. The 14 objectives and 48 strategic actions are prioritized in this table.

Summary Table of Objectives & Strategic Actions	Working Group Priority
Objective H1- Reduce the negative impacts of visitors and increase safety	A
Strategic Actions:	
a) Set and manage visitor limits and access points*	Priority
b) Effectively enforce use regulations, by zone	
c) Establish and maintain visitor entry and passage systems*	Priority
d) Gather relevant information regarding visitor levels and user behavior	
e) Review and adjust reserve boundaries as needed	
f) Minimize impacts of unexploded ordinance	
Objective H2- Protect and stabilize cultural resource sites	A
Strategic Actions:	
a) Identify the most threatened cultural resource sites requiring protection	
b) Implement protection and stabilization plans for high priority cultural resource sites*	Priority
c) Establish and enforce rules to govern appropriate visitor behavior	
d) Inventory all archeological sites found within and adjacent to the reserve	
Objective H3- Preserve knowledge and promote awareness of the reserve	B
Strategic Actions:	
a) Establish an information and interpretation program*	Priority
b) Implement and operate a volunteer program*	Priority
c) Promote cultural awareness to understand regional significance and establish a sense of place	
Objective A1- Control ungulate populations	A
Strategic Actions:	
a) Improve our understanding of ungulate impacts and controls	
b) Deter and remove ungulates out of the reserve*	Priority
c) Exclude ungulates from entering the reserve	
Objective A2- Control top alien invasive plants and animals in terrestrial habitats	B
Strategic Actions:	
a) Remove predatory mammals from around anchialine pools	
b) Reduce alien invasive plant populations in native habitats	
c) Reduce alien invasive insect populations in native habitats	
d) Prevent new alien introductions	
Objective A3- Control Priority Alien Organisms in Aquatic Habitats	B
Strategic Actions:	
a) Remove predatory fish from coral reefs and anchialine pools	
b) Detect alien algae density and emerging threats on coral reefs and anchialine pools	
c) Investigate the most effective ways to address invasive and emerging threats	
Objective A4- Actively Restore Native Plant and Wildlife Assemblages	C
Strategic Actions:	
a) Replant native species at test sites in anchialine and shrubland habitat.	

b) Implement a native habitat restoration plan for the reserve	
Objective L1- Maintain high coastal water quality	B
Strategic Actions:	
a) Prevent or minimize sources of land-based pollution into reserve waters	
b) Upgrade sewage systems within and adjacent to the reserve	
c) Educate neighbors on pollutant impacts and reduction efforts	
d) Monitor water quality for coral reefs within reserve waters	
Objective L2- Reduce upland development impacts	C
Strategic Actions:	
a) Designate and prevent development within a reserve buffer zone	
b) Review and influence progress on proposed development projects	
c) Acquire and hold adjacent lands and infrastructure	
Objective L3- Prevent or minimize manmade light pollution within reserve boundaries	C
Strategic Actions:	
a) Prevent or minimize sources of manmade light pollution	
b) Educate neighbors on light pollution impacts and reduction efforts	
Objective M1- Secure and sustain the level of human and financial resources needed	A
Strategic Actions:	
a) Implement a reserve sustainable financing plan by 2011*	Priority
b) Hire a full-time reserve manager by 2011*	Priority
c) Build the technical capacity of the professional ranger program	
d) Establish a reserve user fee program	
e) Empower and strengthen the Advisory Group	
Objective M2- Provide Biological Resource Status Information for Management	B
a) Conduct biological status monitoring of terrestrial resources.	
b) Conduct biological status monitoring of aquatic resources.	
Objective M3- Provide on-site infrastructure to meet management needs	B
Strategic Actions:	
a) Complete reserve facility and infrastructure planning	
b) Improve and maintain reserve access gates and roads	
c) Improve and maintain reserve visitor facilities	
d) Improve and maintain reserve waste management	
e) Improve and maintain ranger stations and staff offices	
Objective M4- Initiate and maintain strategic partnerships	A
Strategic Actions:	
a) Identify strategic partnership needs under the plan*	Priority
b) Recruit partners in support of the plan's implementation*	Priority

**The working group prioritized the objectives as A, B, or C (A= highest priority), and identified the top ten actions that need to be implemented first.*

2.4 Budget and Sustainable Finance

a) Introduction

The purpose of this section is to gain a better understanding of the financial needs of the Reserve and to introduce several options for sustainable funding. Once we have a clear picture of the current and future financial requirements for managing ʻĀhihi-Kīnaʻu NAR, we want to take you through the updated budgets and explore feasible financing mechanisms that will help generate revenues for the Reserve so that it can augment its State funding. It is important to emphasize here that the goal is NOT to run the NAR as a money-making enterprise or a business for profit's sake. Rather, the goal of this sustainable finance plan is to identify what the funding shortfalls are under different management scenarios and then raise enough reliable money locally to support the Reserve's conservation and management costs. Raising the necessary funds for conservation management will enable the NARS staff to protect and maintain ʻĀhihi-Kīnaʻu's unique natural attributes so that they can be enjoyed by Hawaiʻi's residents and its visitors well into the future.

b) Historical Operating Budget and Reserve Management

During the period between 1985 and 2010, the Reserve has seen its staff roster grow from one-quarter (¼) full-time employees (FTE) to six (6) FTEs. The Reserve was able to hire staff to carry out its mandate by using NAR funds and a four year Hawaiʻi Tourism Authority (HTA) grant. The past few years, however, have seen a dramatic decrease in both funding sources due to state revenue shortfalls and the completion of the HTA grant. Given the economic crisis that started in 2008, and the increase in the number of visitors to the Reserve, the need for funding is all the more critical and requires the ʻĀhihi-Kīnaʻu management plan working group to consider revenue generation to stop and reverse the financial bleeding. The aim of this plan is to identify the management costs and to stabilize the operational management of the Reserve by exploring new ways to generate revenues so that the Reserve can be sustainably managed.

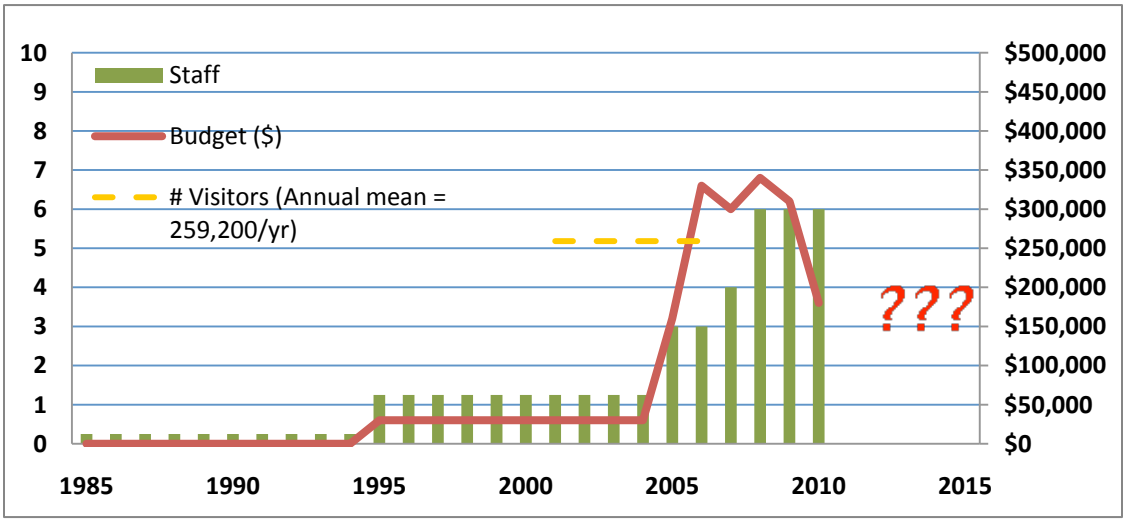

Figure 25. Visitorship, staffing and operating budget at ʻĀhihi-Kīnaʻu from 1985-2010.

c)

d) Protected Areas and Sustainable Funding

On average, the ʻĀhihi-Kīnaʻu NAR receives over a quarter million visitors per year (CSV Consultants and Hawaii Wildlife Fund 2007). There are many examples from around the world of protected areas successfully using various funding mechanisms to cover its operational costs (Hawaiʻi, USA, Australia, Belize, Costa Rica, Kenya, Palau and the Philippines to name a few). Ensuring that tourism follows a sustainable path and that it contributes to sustainable management of protected areas requires concrete partnerships and enhanced collaboration across sectors from the tourism industry, government at all levels, protected area managers and planners, and the visitors themselves. One way the tourism sector can contribute to help cover the costs of management is through supporting various fees. For example, fees that are used in Hawaiʻi and protected areas worldwide include: entrance, recreation, user, concession, merchandise sales, taxes license and permits, and private donations. The bottom line is that government funding is less reliable and we must try feasible mechanisms to generate the necessary revenues to support management and conservation at ʻĀhihi-Kīnaʻu NAR. For example, visitors to ʻĀhihi-Kīnaʻu can help the sustainable management of the Reserve by sharing some of the costs of operations and maintenance through user fees. Experiences locally and worldwide show that the willingness to pay by visitors to special places is quite high. We need only to tap into this ready source of funding and use it to help support the costs of managing the Reserve.

e) Use of fees as a sustainable finance mechanism

Fees have been used to raise funds for site management where visitor use is high in several Hawaiʻi areas, including Hanauma Bay Nature Preserve, Haleakala and Volcanoes National Parks, Diamond Head and Pali State Parks, Na Ala Hele Trails (per–person for commercial operators), and soon at the Mokulua Islands State Wildlife Sanctuary (per–person for commercial operators). Fees range from $5 per person to $10 per car. Hawaiʻi residents are exempt from these fees at some locations like Hanauma Bay. Even with these local and world-wide precedents, fees can encounter a less than enthusiastic response if not rolled out properly. Guidelines on encouraging public support for user fees include:

1. Use fee revenues for quality improvements to trails, signs/maps, toilets, and other facilities;
2. Make small fee increases rather than making them in large jumps;
3. Use moneys for operational costs rather than as a control mechanism for visitor entry;
4. Retain and use money for specific, known, reserve purposes, rather than for general revenues;
5. Use extra money for conservation of the area visited, and;
6. Provide abundant information to the public about the income earned and the actions funded through it. (Source: Eagles et al., 2002)

When done right and with enough lead time and education given to the various stakeholders, user fees and donations are good, steady sources of revenue to help fill the funding gaps in protected areas. The management plan working group continues to strongly support a sustainable finance mechanisms for the reserve, such as the collection of an entry fee (Hawaiʻi residents exempted) and a guided hike fee. Collected funds should stay on-site and be used for management of the ʻĀhihi Kīnaʻu NAR. The financial analysis of these ideas showed

that substantial revenues could be generated from implementing both parking and guided hike fees and would help in meeting the management costs of the Reserve.

For the guided hikes, working group members considered the relative benefits and drawbacks of whether to concession out the hikes, or let a ranger staff provide the hikes. The working group prefers that the hikes are staff-led, and recommends these guiding principles for any entity managing the hikes (non-profit, for profit, or staff):

- Regular training for hike leaders
- Frequency of visitors are limited so as not to cause harm to resources
- Sufficient oversight by the agency (DOFAW)

For entry fee collection, in-house management is preferred. However, it may need to be managed through a concession as it may be too resource intensive to manage in-house.

Examples of staff required to manage entry fees include:

- Hanauma Bay employs 13 people to staff cashier booths for entry fees
- Haleakalā has 7 staff and a machine for entry fee collection

f) Operating Budget

In order to know how much money to raise, we must first know how much it takes to operate and effectively manage the Reserve for the next five years. Once these basic, essential figures are identified and costed, we explore expanding the fundraising efforts so that moderate to full (ideal) conservation management scenarios can be considered. It is worth re-emphasizing here that the primary purpose of generating funds is for the preservation and protection of the Reserve. This, in addition to the principles of carrying capacity and respect for this special place should, above all else, remain paramount in considering any revenue generating ideas. There are many cases where visitor management and maximizing revenues become the primary goals of management and sadly, the protected area deteriorates because it is overused and "loved to death." Hence, the need for this management plan that includes visitor education, enforcement and limiting the impacts of visitors' activities at the Reserve. Below are descriptions of what the different management scenario budgets include. A more detailed description of the objectives and strategic actions can be found in Section 2.3 and a summary in the Appendix.

g) Limited Management (low scenario):

To manage the ʻĀhihi-Kīnaʻu NAR at its most basic level, approximately $400,000 a year is needed for the next five years. This is the absolute minimum required to secure and manage a Reserve of this size, popularity and usage. Anything less than this barebones budget would cause the Reserve to be ineffectively managed and slip into deterioration due to lack of human capacity and financial resources. The budget for this scenario includes salaries and benefits for five rangers and a manager, remote toilets, solid waste management, environmental analyses, vehicle maintenance and replacement costs, an all-terrain vehicle, operations equipment and supplies. This is the baseline to which other scenarios are added.

h) Moderate Management (medium scenario)

In addition to the base costs above, the moderate management scenario includes additional conservation and management activities that preserve and enhance the wilderness values of the

ʻĀhihi-Kīnaʻu NAR. Under this scenario, several key objectives and strategies are funded including: reducing the negative impacts of visitors and increasing safety, protect and stabilize cultural resource sites, control ungulate populations, secure and sustain the level of human and financial resources needed, and initiate and maintain strategic partnerships. This scenario includes major capital improvement projects like the fencing required to keep out ungulates in years 3 and 4. While the funding needed for this level of management is more than twice the baseline level, it is achievable through creative fundraising and multi-sectoral partnerships.

i) Full Management (high scenario)

The high or ideal scenario aims to provide for full management of the the ʻĀhihi-Kīnaʻu NAR. This includes on-site infrastructure to meet management needs, monitoring for the status of biological resources to inform management, reduce upland development impacts, prevent or minimize manmade light pollution within the reserve boundaries, preservation of knowledge about ʻĀhihi-Kīnaʻu, promote awareness of the reserve, controlling of top alien invasive plants and animals in both terrestrial and aquatic habitats, maintenance of high coastal water quality, and active restoration of native plant and wildlife assemblages. Clearly, in order to conduct management and activities that will go beyond the baseline level, more funding will be necessary. While this scenario may seem ambitious, it is all essential for the long-term management of preserving the ʻĀhihi-Kīnaʻu NAR and is very achievable as well with increased levels of fundraising.

j) Funding Gap Analysis

The table below illustrates the required 5-year funding under a low, medium and high management scenario. It also lays out the projected income from the State NAR Fund allocation to ʻĀhihi-Kīnaʻu and the potential revenues generated from implementing a parking fee and guided tours program.

Table 23. Operating Costs, Management and Revenue Generation Scenarios for ʻĀhihi-Kīnaʻu Reserve.

	Year 1	Year 2	Year 3	Year 4	Year 5
Operating Costs & Revenues ($)	**2011**	**2012**	**2013**	**2014**	**2015**
LOW (barebones/austere scenario)	407,877	416,790	382,729	383,698	384,695
MEDIUM (moderate scenario)	827,877	726,790	1,002,729	1,193,698	544,695
HIGH (ideal/best scenario)	1,022,877	951,790	1,202,729	1,598,698	924,695
Annual Income (State NAR Fund)	**180,000**	**180,000**	**225,000**	**225,000**	**225,000**
Variance analysis BEFORE revenue generation					
Funding gap in LOW scenario	(282,877)	(291,790)	(226,479)	(227,448)	(228,445)
Funding gap in MEDIUM scenario	(702,877)	(601,790)	(846,479)	(1,037,448)	(388,445)
Funding gap in HIGH scenario	(897,877)	(826,790)	(1,046,479)	(1,442,448)	(768,445)
Variance analysis AFTER revenue generation					
Net income from guided tours	84,820	132,140	128,667	125,020	121,191
Net income from parking fees	306,000	330,000	329,400	328,782	328,145
Total net income (parking + tours)	**390,820**	**462,140**	**458,067**	**453,802**	**449,337**
Profit/Loss under LOW scenario	107,943	170,350	231,588	226,354	220,892
Profit/Loss under MEDIUM scenario	(204,114)	31,707	(280,469)	(475,703)	168,835
Profit/Loss under HIGH scenario	(507,057)	(396,357)	(588,412)	(988,646)	(150,273)

k) Income from the Natural Area Reserve Fund

The main source of income for the ʻĀhihi-Kīnaʻu NAR is from the NAR Fund. This is money derived from a tax on all transfers or conveyance of realty or any interest therein in the State of Hawaii as established by HRS 195-9, which created this special NAR Fund from which ʻĀhihi-Kīnaʻu draws. Currently, 20% of this conveyance tax goes to the NAR Fund and from this, $125,000 a year goes to ʻĀhihi-Kīnaʻu NAR. In 2013, the percentage that goes to the NAR fund is scheduled to increase to 25%, which is why the projected income from 2013-2015 goes up to $,156,250 from $125,000 during 2011-2012. This is an important source of income for the Reserve and is one of its main lifelines. It is clear, however, that even at increased levels of funding from the NAR Fund, there is not enough to meet even the baseline management scenario, which is why the ʻĀhihi-Kīnaʻu Working Group has explored and pursued alternative revenue generating mechanisms to supplement its Reserve's income.

l) Current funding levels

Again, the current 2010 funding is insufficient to support the most basic staffing level, which is vitally important to maintain in order to protect and preserve the Reserve's resources. If funding and resources are not increased to support the Reserve's management, it may deteriorate further, along with public appreciation, enjoyment, and respect for the area. However, it is worth noting, that the limited (LOW) budget scenario presented here is by no means enough to preserve and run the Reserve at the level that will satisfy the mission and goals presented in this plan, but rather merely insures basic staff presence and operations. That means, that in addition to the two sources of income-generating ideas presented, more funding is needed to implement this plan. Thus, the budget for the LOW scenario presented above is what we call the bare-minimum and is only a starting point for increased levels of Reserve management.

Note in the figure below that even with the annual income from the NAR Fund, there is still a financial shortfall to implement the base level of management. This situation requires that that the Reserve at least doubles their current funding starting in Year 1 through Year 5. This is the reality without any other source of income such as grants and other revenue generation.

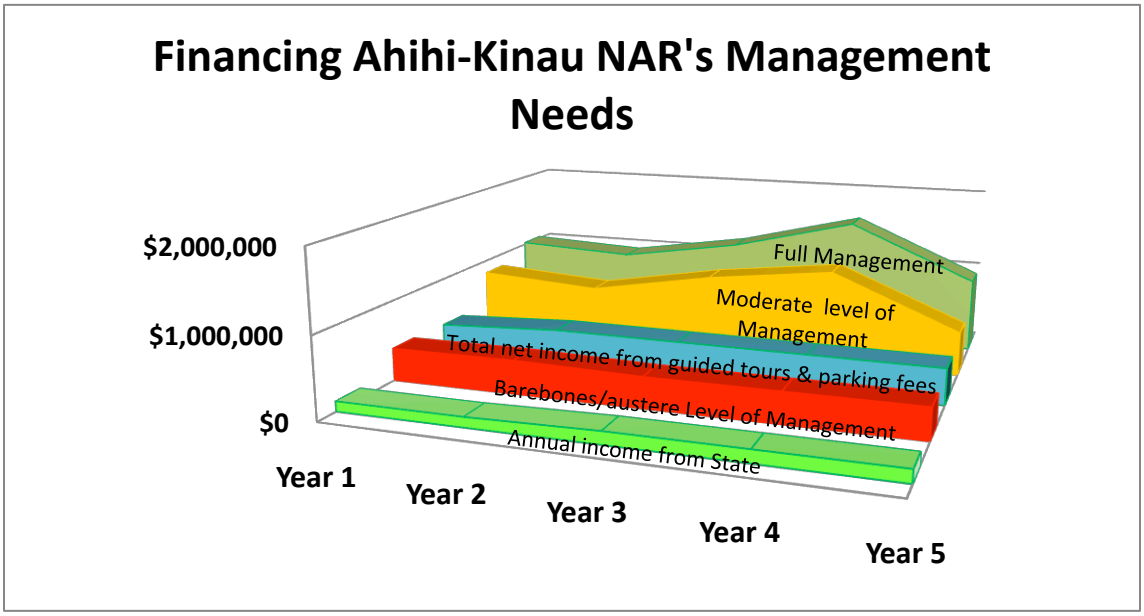

Figure 26. Comparison of total 5-year funding gaps with and without sustainable financing.

m) Reduction of funding gap through revenue generation

With revenue generation at ʻĀhihi-Kīnaʻu NAR, through parking fees and a guided tours program, enough monies can be raised to meet and even exceed the financial costs of the base level of management. This amount can be raised assuming a $5/day charge on vehicles at 200 vehicles per day (this is based on historical visitation averages from human use surveys). The number and pricing of guided tours would be $35 per tour, at 24 people per day, 5 days a week (only in low sensitivity areas) in order to generate these projected revenues. Assuming these income generating programs are implemented, together with NAR Funds, the net profit would be enough to cover the costs of the necessary base level of management. The "surplus" would go directly into funding some of the more urgent activities under the higher levels of management. Overall, generating these funds through the parking and guided tour fees can reduce the total 5-year funding gap by as much as 63% (Figure 27).

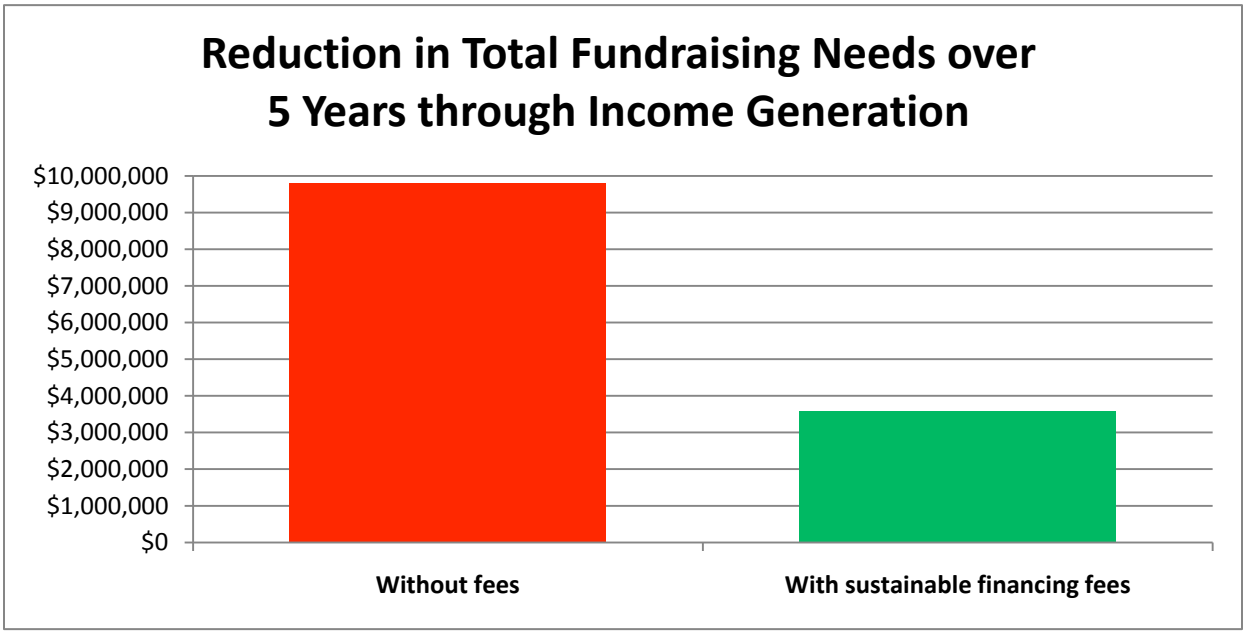

Figure 27. Comparison of total 5-year funding gaps with and without sustainable financing.

This supplemental income makes fundraising for the higher level management activities much more feasible. By reducing the amount that needs to be raised, the Reserve, in close collaboration with partners could apply for grants and solicit donations that are targeted and specific to the remaining key conservation activities. The capital improvements (fencing and management facilities) proposed in years 3 and 4 would be an example of this. Generating our own revenue to meet basic management needs also affords us more time to prepare and fundraise for the bigger ticket items that are scheduled for later, after the basic needs have been met. Through collaborative partnerships, coalitions, donors and other supportive groups (ie. Friends of at ʻĀhihi-Kīnaʻu NAR), this Reserve could generate revenues that could sustainably take care of its needs well into the future.

2.5 Measuring Success

a) Introduction

Measuring the results of our management efforts allows us to determine whether we are making progress relative to our desired results and are adapting our actions to successfully address changing conditions within the land- and seascape.

Objectively measuring and honestly reporting on the degree of our success also enhances public trust and our relationship with partners and the Maui community. Therefore, our measures must be designed to enhance our accountability, credibility, and transparency with the public in order to ensure long-term support and return-on-investment. These measures will also serve as the foundation for an improved understanding of what management actions work best under various conditions. Such information will in turn allow for improved decision-making and adaptation of management efforts.

In order to evaluate the level of our success in managing the Reserve, two sets of measures have been identified within this plan:

1) Effectiveness measures – intended to help us understand whether or not our management actions are achieving their desired/intended results; and

2) Status measures – intended to help us understand what the state of our priority natural and cultural resources is through time, and whether or not there are observable changes occurring.

Effectiveness measures will be periodically used to gage the level of achievement made toward each management objective through time. The language used within the description of each objective alludes to the requirements needing to be met for that objective to be fully achieved. The number and type of associated effectiveness measures varies with the complexity, risk, and uncertainty associated with the objective in question. A table of effectiveness measures per objective is provided in the appendix.

Status measures are directly linked to priority resources targeted for conservation, in relation to the key ecological attributes of our conservation targets, and the priority threats we plan to abate. A status for each of the target resources has been set, and in tracking status assessment measures, we aim to increase our understanding of how to move condition of targets from “good” or “poor” to “very good” or “good” viability ranking. A table of status measures per conservation target is provided in the appendix.

b) Methodology

Accepted biological and social survey methods will be employed in the monitoring of effectiveness and status measures. Specific survey instruments and methods used will be developed and implemented under collaboration with and guidance from State biologists, scientific experts, and technical partner organizations.

Baseline data collection of status and effectiveness measures is to be conducted during 2010 and 2011. In some cases, data already exists for certain status measures relating to specific

target resources. Such secondary sources of information will be used as historic information to augment baseline survey efforts conducted. Where similar survey methods have been used, this may allow for a level of comparability and integration of secondary data into Reserve baseline studies, as applicable (e.g., reliability of data assured; adequate sample size provided).

The periodic measurement of effectiveness and status measures is to commence in 2012. Frequency of data collection beyond baseline survey will be dependent upon survey methods used and difficulty of measurement (logistically, financially, and practically). For example, in some cases, data for status measures may only be collected every few years or semi-annually. In other cases, some effectiveness measures may be collected monthly or even daily.

Identified effectiveness and status measures are presented in two tables in the appendix. The methods for and frequency of data collection and the responsible party(ies) involved in data collection will be identified in the implementation of this plan.

c) Evaluation

A formal evaluation of the Reserve's management effectiveness will be completed in 2015, pursuant with the approved goals and objectives. The results of this evaluation will be published and provided to the public, particularly with the Reserve's partners, stakeholders, and community interest groups. Management partners will use evaluation results to assess overall performance, make necessary adjustments in resource allocations and management activities, and adapt to changing conditions or threats on site. Adaptations made to management actions will be done in support of any observed improvements and/or maintenance of the viability of priority resource targets.

d) Summary of inventory and monitoring tasks

Inventory and monitoring actions for conservation targets are included within the strategic actions. The inventory and monitoring table in the appendix summarizes the inventory and monitoring related tasks under each strategic action from Section 2.3. Many of these baseline inventory or monitoring actions address the status measures/indicators that are listed by conservation target in the appendix. Data collected for status indicators can help managers know if they are meeting the objectives and increasing the viability of resources, thereby providing information for improved management.

Appendix

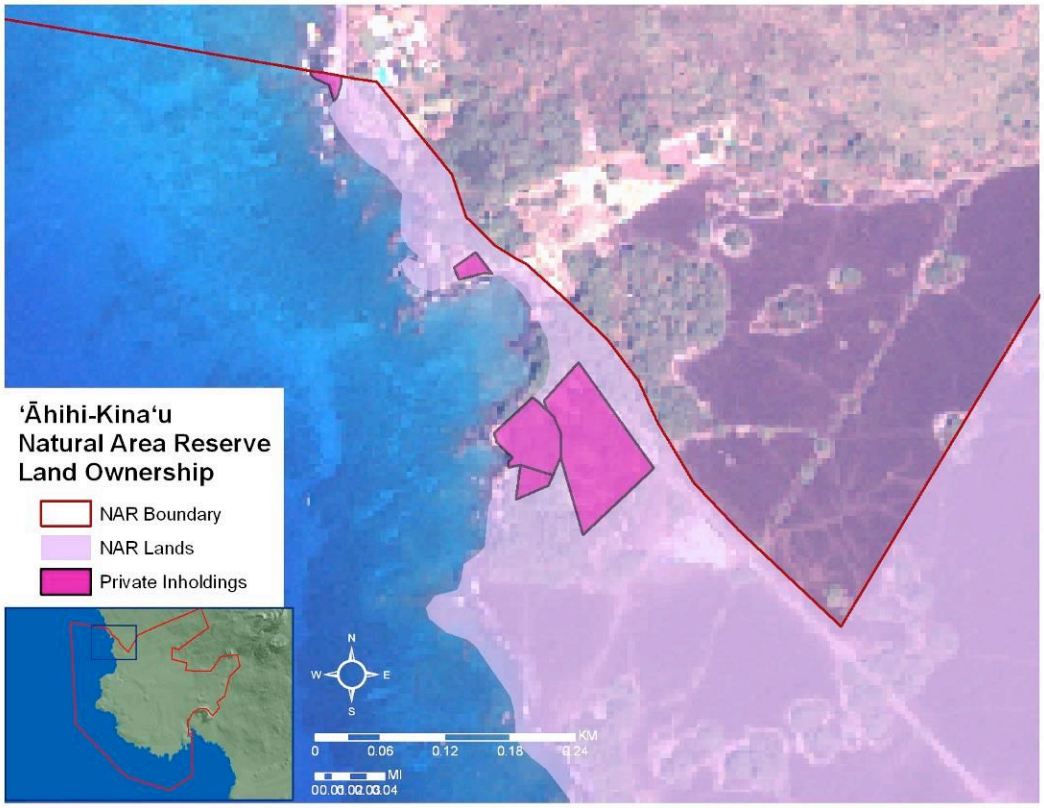

Figure 28. Map of private land ownership within the Reserve (Stephanie Tom).

Figures 29-32. Results Chains illustrate how a management strategy can lead to threat reduction through a series of actions and their intermediate results. By understanding our assumptions about what we expect to happen, this step-wise progression makes for better strategic actions.

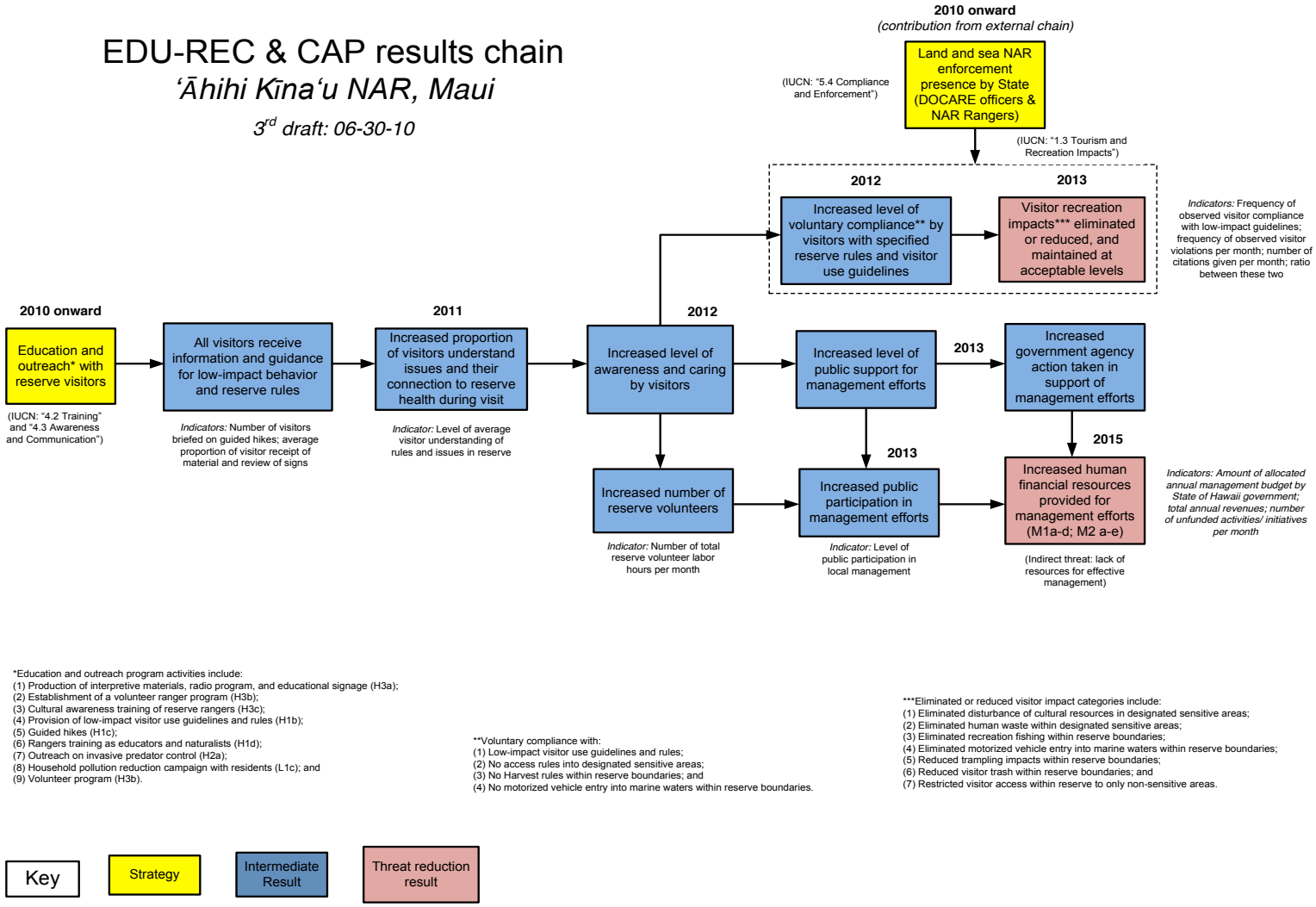

Figure 27. Results Chain for the strategy of Education (EDU) to address recreation (REC) and management capacity (CAP) needs.

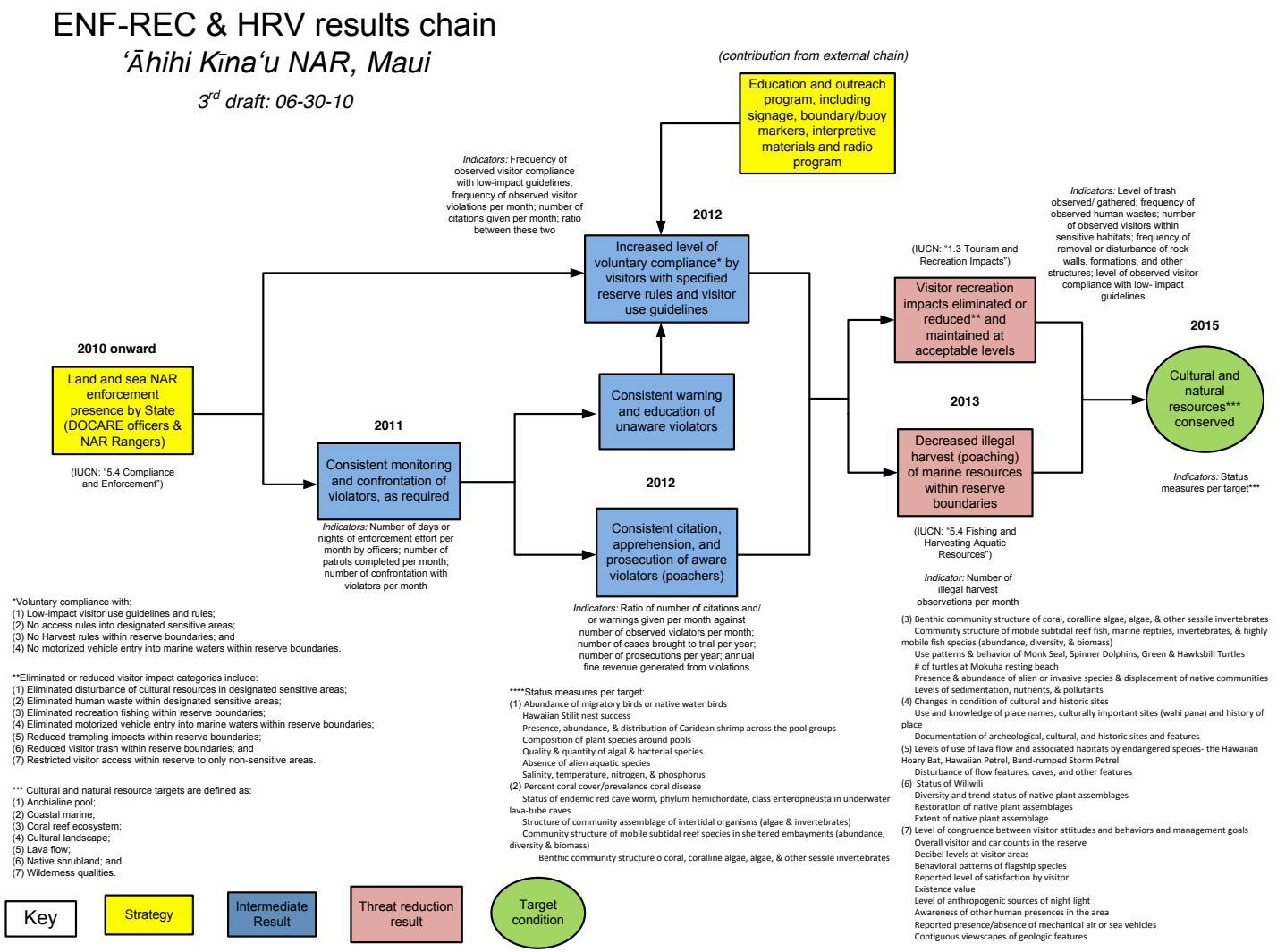

Figure 28. Results Chain for the strategy of enforcement (ENF) to address recreational (REC) and illegal harvest (HRV) threats.

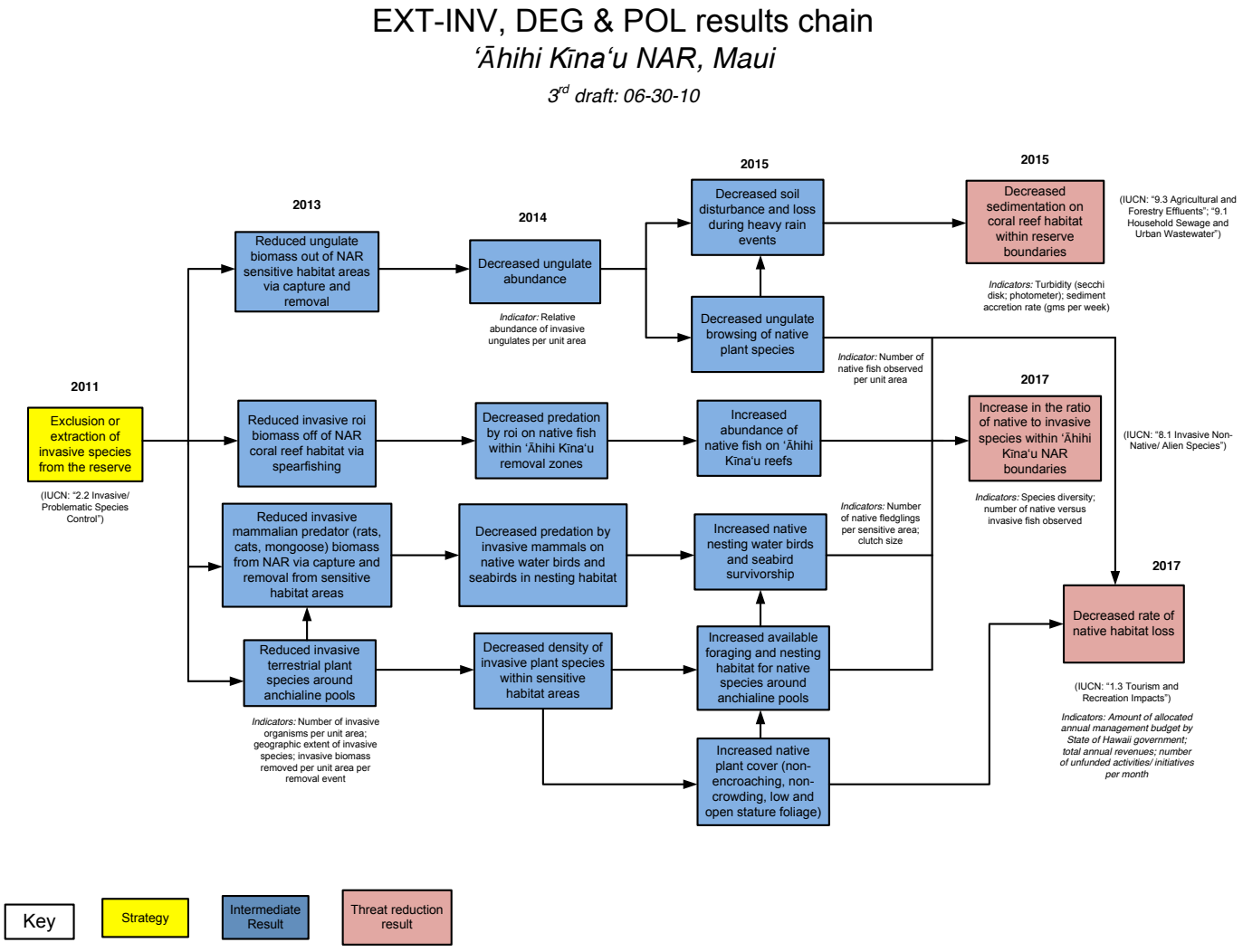

Figure 29. Results Chain of the strategy of extraction (EXT) of alien or invasive (INV) species to address threats of resource degradation (DEG) and pollution (POL).

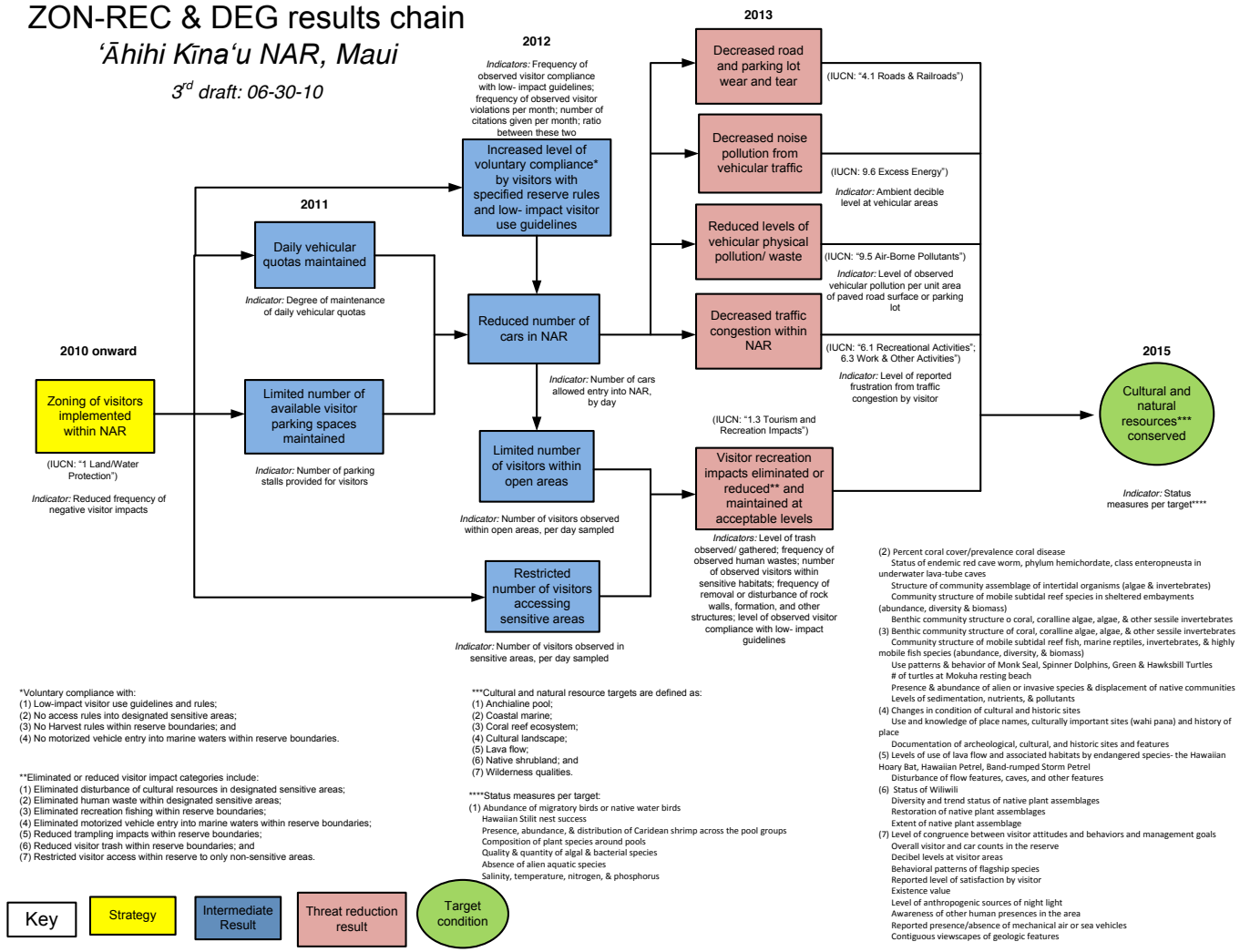

Figure 30. Results Chain for the strategy of zoning (ZON) to address threats from recreation (REC) and resource degradation (DEG).

Table 24. Selected effectiveness measures by objective.

Selected Effectiveness Measures by Objective	
Objectives	**Indicators**
Objective H1- Reduce the negative impacts of visitors	-Reduced frequency of negative visitor impacts -Number of parking stalls provided for visitors -Number of cars allowed entry into NAR, by day -Number of visitors observed within open areas, per day sampled -Number of visitors observed in sensitive areas, per day sampled -Level of reported frustration from traffic congestion by visitor -Level of average visitor understanding of rules and issues in reserve -Number of total reserve volunteer labor hours per month -Ratio of number of citations and/or warnings given per month against number of observed violators per month; number of cases brought to trial per year; number of prosecutions per year; annual fine revenue generated from violations -Number of illegal harvest observation per month, per impact category
Objective H2- Protect and stabilize cultural resource sites	-Frequency of removal or disturbance of rock walls, formations, and other structures
Objective H3- Preserve knowledge and promote awareness of the reserve	-Number of visitors briefed on guided hikes; average proportion of visitor receipt of materials and review of signs -Level of observed visitor compliance with low-impact guidelines -Level of congruence between visitor attitudes and behaviors and management goals
Objective A1- Control ungulate populations	-Relative abundance of invasive ungulates per unit area - Invasive ungulates removed per unit area per removal event
Objective A2- Control top alien invasive plants and animals in terrestrial habitats	-Number of invasive organisms per unit area; geographic extent of invasive species; invasive biomass removed per unit area per removal event
Objective A3- Control top alien invasive organisms in aquatic habitats	-Number of native bird fledglings per sensitive area -Species diversity; number of native versus invasive fish observed
Objective A4- Actively restore native plant assemblages	-Geographic extent of native habitat: presence/absence of native flora and fauna per unit area per sensitive habitat type
Objective L1- Maintain high coastal water quality	- Levels of fecal bacteria, nitrates, phosphorus, dissolved oxygen/biochemical oxygen demand, conductivity, turbidity, temperature, total solids, and toxics in nearshore ocean waters
Objective L2- Reduce upland development impacts	-Density of development surrounding Reserve -Distance of new development from reserve boundaries
Objective L3- Prevent or minimize manmade light pollution within reserve boundaries	-Nighttime levels and location of artificial light
Objective M1- Secure and sustain the level of human and financial resources needed	-Level of public participation in local management -Amount of allocated annual management budget by State of Hawaii government; total annual revenues; number of unfunded activities/initiatives per month
Objective M2- Conduct status monitoring for biologic resources	-Status monitoring conducted
Objective M3- Provide on-site infrastructure to meet management needs	-Infrastructure maintained; meets management needs
Objective M4- Initiate and maintain strategic partnerships	-Partnerships maintained; meets management needs

Table 25. Selected status measures by target.

Selected Status Measures by Target	
Target	**Indicators**
Anchialine Pool	-Abundance of migratory birds and native water birds -Hawaiian stilt nest success -Presence, abundance, & distribution of *Caridean* shrimp across the pool groups -Composition of plant species around pools -Quality & quantity of algal & bacterial species -Presence/absence of alien aquatic species -Water quality parameters: Salinity, temperature, nitrogen, & phosphorus
Coastal Marine	-Percent coral cover/prevalence coral disease -Structure of community assemblage of intertidal organisms (algae & invertebrates) -Community structure of mobile subtidal reef species in sheltered embayments (abundance, diversity & biomass) -Benthic community structure of coral, coralline algae, algae, & other sessile invertebrates
Coral Reef Ecosystem	-Benthic community structure of coral, coralline algae, algae, & other sessile invertebrates -Community structure of mobile subtidal reef fish, marine reptiles, invertebrates, & highly mobile fish species (abundance, diversity, & biomass) -Use patterns & behavior of Hawaiian monk seal, Spinner dolphins, Green & Hawksbill turtles -Presence & abundance of alien or invasive species & displacement of native communities -Levels of sedimentation, nutrients, & pollutants
Cultural Landscape	-Changes in condition of cultural and historic sites -Use and knowledge of place names, culturally important sites, and history of place -Documentation of archeological, cultural, and historic sites and features
Lava Flow	-Presence and location of nesting seabirds -Disturbance of flow features, caves, and other features -Extent and status of littoral invertebrates - Extent and status of cave and new lava aeolian invertebrates
Native Shrubland	-Forest stand structure and reproductive success of wiliwili -Extent and status of native insects and arthropods -Diversity and trend status of native plant assemblages - -Extent of native plant assemblage
Wilderness Qualities	-Overall visitor and car counts in the reserve -Behavioral patterns of flagship species -Reported level of satisfaction by visitor -Existence value -Level of anthropogenic sources of night light -Reported presence/absence of mechanical air or sea vehicles -Contiguous viewscapes of geologic features

Table 26. Summary of inventory and monitoring tasks under strategic actions.

Strategic Action	Inventory and Monitoring
Action H1(e) – Gather relevant information regarding visitor levels and user behavior.	(i) design a human use monitoring protocol to periodically collect visitor levels, behaviors, impacts, and relevant user information using accepted methods; (ii) periodically conduct human use monitoring in a timely manner.
Action H3(c) – Promote cultural awareness to understand regional significance and establish a sense-of-place.	(i) conduct an in-depth cultural landscape study of available archival sources, including stories, songs, maps, Hawaiian language newspapers, and other historic documents; (ii) interview and document oral histories of lineal descendants with *kuleana* over Reserve lands and other knowledgeable island residents; (iii) research and document fishing and other resource harvesting/gathering traditions of area.
Action A1(a) – Improve our understanding of ungulate impacts and controls.	(i) complete a survey to estimate ungulate population numbers and assess habitat use patterns and impacts; (ii) conduct periodic monitoring of ungulate populations and behavior.
Action A1(c) – Exclude ungulates from entering the Reserve.	(iv) monitor and maintain perimeter fence line around the Reserve.
Action A2(a) – Remove predatory animals from around priority anchialine pools and seabird nesting areas.	(iii) monitor the effects of reduced predators on native waterbird populations and nesting areas, monitor predator activity, bird demography and breeding success; (v) survey to determine presence/absence and location of nesting seabirds, automated vocalization recording devices should augment the studies, and specific management strategies should be based on results of studies.
Action A2(b) – Reduce alien plant populations in native habitats.	(iii) monitor and control recruitment of alien invasive seedlings through time; (iv) develop and explore effective methods for landscape monitoring of vegetation structure and composition in lava flow, shrublands, and anchialine areas of the reserve.
Action A2(c) – Reduce alien invasive insect populations in native habitats.	(i) monitor effects of bio-control on alien invasive gall wasps and on *wiliwili* trees in native forest and shrubland habitat within the Reserve; (iii) conduct baseline inventory to document presence/absence of other harmful alien invertebrates.
Action A2(d) - Prevent new alien introductions	(ii) continue to identify other high priority alien or other biological threats for early detection and further study using MISC priority species determinations. These are reviewed as needs/discoveries arise and tied to incipient species which are most economically and efficiently controlled.
Action A3(b) – Detect alien algae density and emerging threats on coral reefs and anchialine pools.	(i) conduct periodic monitoring of marine intertidal areas for alien algae according to interagency standards for early detection; (ii) conduct periodic monitoring of anchialine aquatic ecosystems according to interagency standards for early detection of the spread of alien invasive plant and animal species, as well as other changes, and to provide information for trends and for comparison to other pool sites in Hawaiʻi; (iii) conduct periodic monitoring for coral bleaching and disease, crown-of-thorns sea stars and marine invasive species in accordance with interagency standards; (v) continue to identify other high priority marine threats for early detection and further study.
Action A3(c) – Investigate the most effective ways to address aquatic invasive and emerging threats.	(i) initiate an investigation into the trends and status of diseased coral, diseased fish, and crown-of-thorns sea stars' outbreaks within the Reserve.
Action A4(a) – Replant native species at test sites	(iii) monitor and document survivorship rates, species diversity, and successional changes observed for restored native plant assemblages at these sites.

Strategic Action	Inventory and Monitoring
in anchialine and shrubland habitat.	
Action A4(b) – Implement a native habitat restoration plan for the Reserve.	(i) conduct a survey to characterize the status of native plants, native invertebrates and native wildlife within the Reserve (including spatial extent) and compare results to 1989 baseline survey; (v) monitor and maintain restored native plant assemblages and remove alien invasive plant recruits.
Action L1(a) –Prevent or minimize sources of land-based pollution into Reserve waters.	(i) assess and identify primary point and non-point source contributions of land-based pollution into Reserve waters, including nutrient loading and soil erosion from up-slope development
Action L1(d) – Monitor water quality for coral reefs within Reserve waters.	(i) conduct periodic water quality monitoring at sampling stations in Reserve waters.
Action L3(a) –Prevent or minimize sources of manmade light pollution.	(i) determine natural ambient light levels at night within Reserve boundaries and if those levels exceed county lighting ordinances; (ii) assess and identify primary sources of light pollution that contribute to altered/elevated ambient light levels.
Action M2(a) – Conduct biological status monitoring of terrestrial resources.	(i) periodically monitor the status and trends of native plant assemblages, invertebrates in lava-tube caves, new lava, anchialine pools, littoral areas, and shrublands; (ii) monitor the demography, status and trends of seabirds and waterbirds following baseline surveys and restoration plan development in Action A4(b).
Action M2(b) – Conduct biological status monitoring of aquatic resources.	**(i) continue DAR and Coral Reef Assessment and Monitoring Program (CRAMP) at two sites, Kanahena Point and Kanahena Cove, to track status of coral reef health and trends; (ii) continue periodic monitoring of marine intertidal areas for ʻopihi, other invertebrates and algae to track status and trends according to establish standards; (iii) continue periodic monitoring of anchialine aquatic ecosystems for trends and status according to interagency standards.**

Glossary

Buffer:
A neutral zone between two rival powers that is created to diminish the danger of conflict

Ecosystem:
The complex of a community and its environment functioning as an ecological unit in nature (i.e. lava tubes, coastal dunes, dry and mesic forests, wet forests, alpine shrub/grasslands, and Aeolian (wind-blown))

Endemic:
A species or subspecies of plant or animal which occurs naturally nowhere else; evolving into a different species from the ancestral introduction (i.e. Haleakalā Silversword naturally occurs only on East Maui, nowhere else in the world)

Indigenous:
Organisms which arrived in Hawai'i without the assistance of humans, and are also found elsewhere (i.e. Naupaka kahakai or *Scaveola sericea* and ʻEkaha or Bird's Nest Fern can be found throughout the Pacific)

Invertebrates:
Animals without backbones (i.e. insects, spiders, shrimps, and snails)

Marine:
Saltwater habitat; referring to ocean and coastal ecosystems

Native:
A plant or animal species that got to an area without human intervention; instead it travelled by either wings, wind, and/or water. Both indigenous and endemic are called native

Pristine:
Relatively undisturbed by humans and feral ungulates, and virtually lacking other non-native taxa (plants and animals); entirely native

Protected:
Legally dedicated to the perpetuation of native resource, if necessary

Restoration:
An attempt to remove non-native plants and animals from an area, assuming it will revert to a functioning native ecosystem; can include actual out-planting (replanting species that were once in the area, which have been propagated in a nursery), or it may entail simple removal of non-native vegetation and monitoring the area for natural re-growth

Terrestrial:
Growing in or on the land as opposed to epiphytic (to grow on other plants, rocks, or animals)

Ungulate:
A group of hoofed mammals (i.e. pigs, goats, horses, sheep, deer, cattle, donkeys) which are primarily herbivorous (feed on vegetation); ungulates were introduced to Hawai'i

Weed:
A plant that is not valued where it is growing; outcompetes native species for light and water

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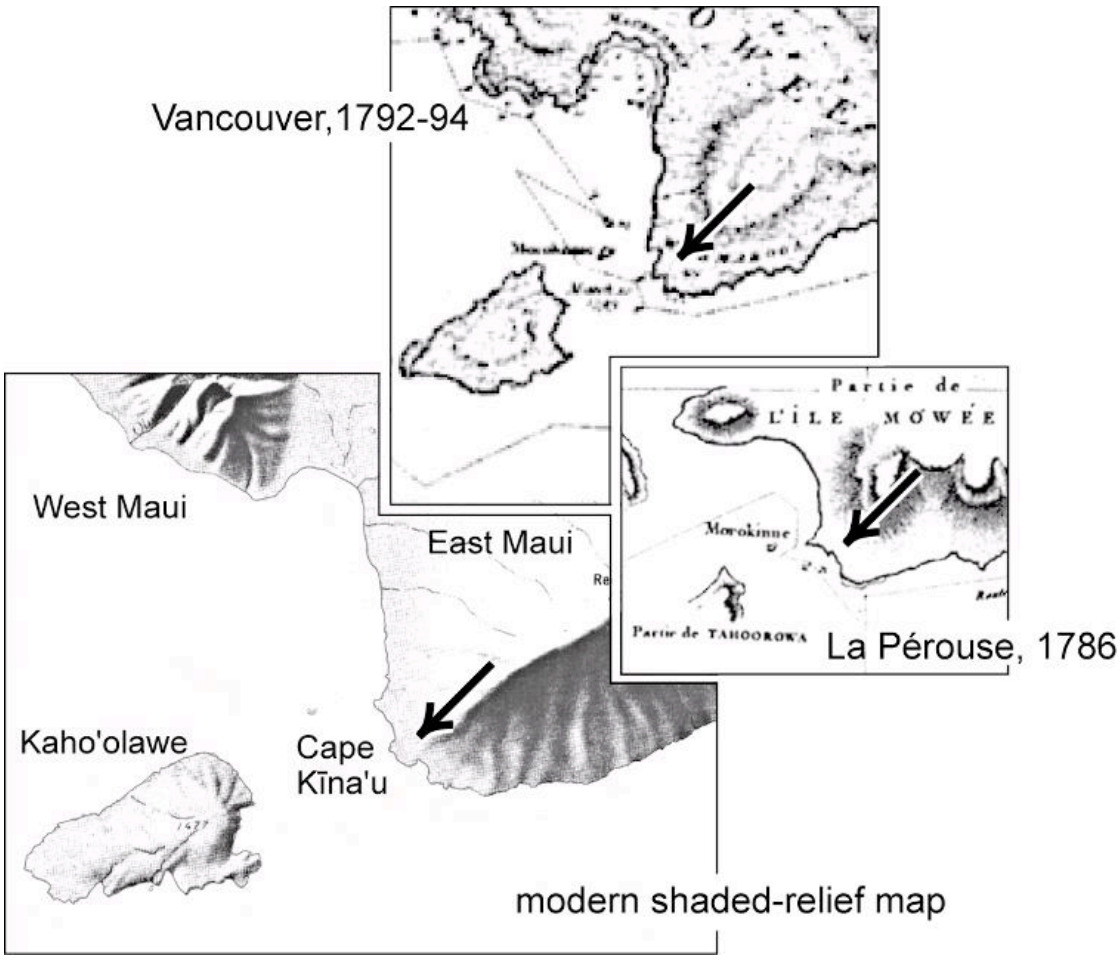
Endnotes

[1] Literally, Red-land or earth (Pukui, Elbert, and Mookini 1974)

[2] Cape Kīna'u is named for Elizabeth Kīna'u (1804-1839) the daughter of Ka-mehameha I and Ka-heihei-mālie. After her aunt Ka-ahu-manu's death she became kuhina nui (regent) for her brother Ka-mehameha III, an office she held until her death in 1839 at the age of 35. In a chant in her honor, Kīna'u is said to have been named for a mythical bird, Ka-manu- kīna'u-a-Pae. Lit., *flaw*. (Pukui, Elbert, and Mookini. 1974).

[3] Discussion of the age of Reserve lava flows:A date of A.D. 1790 was assigned previously to the Kalua o Lapa lava (Oostdam 1965). This age was interpreted from the differences between charts made by explorers La Pérouse, who visited the Hawaiian Islands briefly in 1786, and Vancouver, who made repeated voyages to the islands between 1792 and 1794. Cape Kīna'u is prominent on the Vancouver chart of 1793 but nearly indistinguishable on La Pérouse's chart of 1786 (Figure 3).



Comparison of early exploration charts and the configuration of the East Maui coastline in the vicinity of the 'Āhihi–Kīna'u Natural Area Reserve (map by Dave Sherrod).

When considered critically, however, the charts are not comparable. La Pérouse spent less than 48 hours at the Island of Maui, too little time to place much faith in the details of the coastline on his chart. Vancouver's chart has its own inadequacies; for example, the general shape of Maui is shown less realistically than the earlier presentation from Cook's 1776 voyage (Fitzpatrick 1986). In short, the charts are too imprecise to allow the dating of shoreline features by their presence or absence on one chart or another.

Some Maui residents interviewed in the mid-1800s stated their grandparents saw the Kalua o Lapa lava actively emplaced, and a separate account in the early 1900s made reference to a father-in-law's grandfather also having seen lava flowing (Thurston 1924; Stearns and Macdonald 1942). This evidence and assumptions about generational duration led to an estimation of A.D. 1750 for the emplacement of Kalua o Lapa lava flows. The discrepancy between the oral history and radiocarbon ages for the Kalua o Lapa lava flows has no satisfactory resolution. Information about the early interviews is lost, and neither the questions asked nor intent of the respondents can be verified. The interviews were almost certainly not in the native language of the respondents. The radiocarbon ages are considered the best scientific estimation for the age of the lava flows.

[4] Discussion of the significance of Reserve resources
The criteria used to evaluate the significance of Reserve resources are, a) does the resource represent an outstanding example of a particular type of resource; and b) if so, at what level of significance, worldwide, national, or archipelagic?

Anchialine pools are of global, national and archipelagic significance: Although found in 11 locations worldwide, most abundantly in Hawaiʻi, Fiji, and the Ryukyu Islands, the total area occupied by this habitat is small, as they are restricted to highly porous substrates adjacent to the sea. These pools are highly vulnerable to human and other impacts and need management to continue to exist. Hawaiʻi is the only state in the nation to have anchialine pools and on Maui, these pools are significant, as there are only a few others, which are found south of the Reserve and in Hana. Five of the ten shrimp species found in this habitat are listed as candidate endangered species, one of which is found only in the Reserve. Of the approximately 600 pools found in Hawaiʻi, the pool complexes of the Reserve are widely known as the healthiest, home to multiple endangered species, and numerous rare and migratory species (Brock 2004).

Coral reefs are of national and archipelagic significance: Hawaiʻi's coral reefs are an essential component of island life, providing wave breaks for surfers, food and recreation, and acting as a buffer to protect the land. Hawaiʻi also contains the majority of the nation's coral reefs. On a statewide scale, the Reserve is the second largest marine area that enjoys the benefits of protection and management in the populated islands after Kahoʻolawe Island Reserve. The coral reefs in the Reserve are significant because they are in very good health, especially compared to other parts of the Hawaiian Islands, and have a high level of diversity and abundance of marine life. This is due in part to the long-standing protection of the area, and also because there are fewer land-based stressors, such as agriculture and development, than in many other areas in Hawaiʻi.

Coastal marine habitats are of archipelagic significance: The Reserve is the only rocky coastal ecosystem on Maui protected both from development and the taking of any marine organism. As a result, the marine community including algae, invertebrates such as coral and sea urchins, and fish are uniquely diverse and abundant. The costal boulder habitat also hosts unique native insects no longer found widely in Hawaiʻi such as the endemic marine cricket *Caconemobius sp.*

Cultural landscape is of archipelagic significance: The archeological record of the Reserve constitutes a significant and unique material record of the indigenous Hawaiian occupation of the southeastern coast of Maui, much like other undeveloped areas of Maui and Hawaiʻi in their state of preservation and potential for study and interpretation.

Lava flow formations and habitats are of archipelagic significance: A cultural and biologically significant cave at the Kālua O Lapa cinder cone contains an endemic spider and other invertebrates found nowhere else in Hawaiʻi or the world. Further, such caves are rare on Maui, making this habitat a unique resource in the state. The geology of the Reserve is also of island-ide significance, as it is among the youngest on the island.

Native leeward shrublands and forests are of archipelagic significance: The Reserve contains a large population of the rare *maiapilo* shrub (*Capparis sandwichiana*). *Maiapilo* is considered rare on other Hawaiian Islands, and is a candidate species for federal endangered status. There are 21 native dryland species documented in the Reserve, of which three are rare. The Reserve is part of the less than 2% of this habitat type left in Hawaiʻi.

Wilderness qualities are of national and archipelagic significance: The scenic vistas of the Reserve, with 360 degree views of the land and seascape, are dramatic on many levels. At any vantage point within the Reserve, sweeping and

breathtaking unobstructed views are available from the sea up to the volcanic vent of Kālua O Lapa, and further upward towards the southwest rift zone of Haleakalā. These vistas also provide connection among varied habitats, making it possible for a wide variety of birds, bats, and insects to establish their homes among these landscapes.

[5] Handy (1991) wrote that, "From…Kahikinui, Honuaula, and Kula, the sweet potato was the staple food for a considerable population…This is the greatest continuous dry planting area in the Hawaiian Islands."

[6] The Reserve contains three small Mahele ʻĀina land claim awards, and one land grant in Kanahena *Ahupuaʻa* near the edge of the Puʻu Māhoe lava flow (Desilets et al. 2007:6-9). These four parcels are currently privately owned by parties other than the original claimants, and constitute a very small portion of the Reserve (see Figure 22).The bulk of Kanahena *ahupuaʻa* came to Ruth Keʻelikōlani, who later transferred these to the government (Desilets et al. 2007), which in turn became State land, and later became the Reserve. By 1845, the Hawaiian system of land tenure was being radically altered. Prior to Western contact, all land and natural resources were held in trust by the high chiefs, with the use of lands and resources given to the *hoaʻāina* (native tenant) at the prerogative of the *alii* (chief) and *konohiki* (headman of an *ahupuaʻa*). In contrast, the Mahele ʻĀina of 1848, under King Kamehameha III, instituted a system of private land ownership. As a result of the Mahele ʻĀina, all lands in the Kingdom of Hawaiʻi were placed in one of three categories: crown, government, and *konohiki* . In 1849, the Kuleana Act defined the process for *hoaʻāina* (native tenants) to apply for fee-simple interest in *kuleana* (right, responsibility, property) lands, creating a fourth category. These rights exists today under Hawaiʻi State Law.

[7] Conservation Action Planning (CAP) *is a process to guide conservation teams to develop focused strategies and measures of success. CAP* can be utilized for any project at any scale or set of natural or cultural resources. As actions are taken and outcomes are measured, conservation action plans are revised to incorporate new knowledge. The CAP process helps to: a) identify the project's biodiversity of interest and its current and desired status; b) identify the most critical threats currently or likely to degrade the biodiversity; c) recognize the social, economic, political and cultural factors contributing to the threats or representing opportunities to enhance the biodiversity; d) develop strategies to abate the threats and maintain or restore the biodiversity based on the situation at hand; and, e) implement the strategies, monitor the outcomes and use that information to adapt and learn throughout the life of the project. CAP is part of the international effort to standardize and improve conservation planning and implementation (see *Open Standards for the Practice of Conservation http://www.conservationmeasures.org).* For more information on CAP go to http://conserveonline.org/workspaces/cbdgateway/cap/index_html.

[viii]The objective of class AA waters is for the waters to "remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions. To the extent practicable, the wilderness character of these areas shall be protected. No zones of mixing shall be permitted in this class. The uses to be protected in this class of waters are oceanographic research, the support and propagation of shellfish and other marine life, conservation of coral reefs and wilderness areas, compatible recreation, and aesthetic enjoyment" (Hawaiʻi Administrative Rules 11-54-3).